Baseline Ecological Risk Assessment

Columbia Falls Aluminum Company

2000 Aluminum Drive
Columbia Falls, Flathead County, Montana

Prepared for:

Columbia Falls Aluminum Company, LLC

Prepared by:

EHS Support

July 29, 2019

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Acronyms

µg	micrograms
$\mu mol/g_{OC}$	micromoles per gram organic carbon
2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
ANOVA	analysis of variance
AOC	Agreement and Order on Consent
AST	aboveground storage tank
ATP	adenosine triphosphate
AUF	area use factor
AVS	acid volatile sulfides
BAF	bioaccumulation factor
BCF	bioconcentration factor
BEHP	bis(2-ethylhexyl)phthalate
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BLM	biotic ligand model
BSAF	biota-sediment accumulation factor
BTEX	benzene, toluene, ethylbenzene, and xylene
BTV	background threshold values
BW	body weight
CCC	criterion continuous concentration
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFAC	Columbia Falls Aluminum Company, LLC
CMC	criteria maximum concentration
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CSM	conceptual site model
DOC	dissolved organic carbon
DQO	data quality objective
DSR	Data Summary Report
DU	decision unit
dw	dry weight
EC_{10}	10 percent effect concentrations
Eco-SSL	ecological soil screening levels
ECSM	ecological conceptual site model
EDD	estimated daily dose
EPC	exposure point concentration
EPI	Estimation Programs Interface
EqP	equilibrium partitioning
ERA	ecological risk assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ESB	Equilibrium Partitioning Sediment Benchmarks
ESBTU	equilibrium partitioning sediment benchmark toxic unit
ESV	ecological screening value
FCV	final chronic value

f_{oc}	fraction of organic carbon
FS	Feasibility Study
ft/ft	1 foot by 1 foot cross-sectional gradient of groundwater
ft^3/s	cubic feet per second
ft-amsl	feet above mean sea level
ft-bgs	feet below ground surface
GSD	geometric mean standard deviation
HCN	hydrogen cyanide
HHRA	Human Health Risk Assessment
HMW	high molecular weight
HQ	hazard quotient
HSD	Honest Significant Difference
IC_{10}	10 percent inhibition concentration
IC_{50}	50 percent inhibition concentration
IPaC	Information for Planning and Consultation
ISS	incremental soil sampling
ITRC	Interstate Technology and Regulatory Council
kg	kilogram
L	liter
LANL	Los Alamos National Laboratory
LC_{50}	lethal concentration in 50 percent of test organisms
LL	low level
LMW	low molecular weight
LOAEL	lowest observed adverse effects level
LOEC	lowest observed effect concentration
MATC	maximum acceptable toxicant concentration
MDEQ	Montana Department of Environmental Quality
MDL	method detection limit
mg	milligrams
mg/kg	milligrams per kilogram
mg/kg bw per day	milligrams per kilogram body weight per day
mg/L	milligrams per liter
mi^2	square miles
MPDES	Montana Pollutant Discharge Elimination System
NaCN	sodium-cyanide
NaF	sodium fluoride
NHD	National Hydrography Dataset
NOAA	National Oceanic and Atmospheric Agency
NOAEL	no observed adverse effects level
NOEC	no observed effect concentration
NRWQC	National Recommended Water Quality Criteria
ORNL	Oak Ridge National Laboratory
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-dioxin
PCDF	polychlorinated dibenzo-furan
RAIS	Risk Assessment Information System

RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPD	relative percent difference
RSD	relative standard deviation
RSL	Regional Screening Levels
SAP	Sampling and Analysis Plan
SEDTOX	sediment toxicity
SEM	simultaneously extracted metals
SIM	selected ion monitoring
SLERA	Screening-Level Ecological Risk Assessment
SMDP	scientific management decision point
SOP	standard operating procedure
SPL	spent potliner
SQT	Sediment Quality Triad
SVOC	semi-volatile organic compound
SW	surface water
TAL	target analyte list
TCL	target compound list
TDS	total dissolved solids
TEC	Toxicity Equivalence Concentrations
TEF	toxicity equivalent factor
TEL	toxic effect level
TEQ	Toxicity Equivalency Quotient
TOC	total organic carbon
tPAH	total PAH
TRI	Toxics Release Inventory
TRV	toxicity reference value
TSS	total suspended solids
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	underground storage tank
UV	ultraviolet
VOC	volatile organic compound
WAD	weak acid dissociable
WET	whole effluent toxicity
WHO	World Health Organization
WQB	water quality benchmark

1 Introduction

On behalf of Roux Environmental Engineering and Geology, D.P.C. (referred to herein as Roux) and Columbia Falls Aluminum Company, LLC (CFAC), EHS Support LLC (EHS Support) has prepared this Baseline Ecological Risk Assessment (BERA) as part of the ongoing Remedial Investigation/Feasibility Study (RI/FS) of the former CFAC aluminum reduction facility (commonly referred to as an aluminum smelter) Superfund Site located in Flathead County, Montana (Site). The RI/FS is being conducted pursuant to the Administrative Settlement Agreement and Order on Consent (AOC) dated November 30, 2015, between CFAC and the United States Environmental Protection Agency (USEPA) (Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA] Docket No. 08-2016-0002).

As part of the RI/FS, a Site-wide ecological risk assessment (ERA) is being conducted in accordance with *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (ERAGS; USEPA, 1997). Per USEPA (1997) the functions of the ERA are to:

- Document whether actual or potential ecological risks exist at the Site;
- Identify which constituents present in exposure media at the Site pose an ecological risk; and
- Generate data to use in evaluating cleanup options

In addition to ERAGS, other relevant guidance documents that may be consulted to support the ERA process at the Site include, but may not be limited to, the following:

- *Determination of the Biologically Relevant Sampling Depth for Terrestrial and Aquatic Ecological Risk Assessments* (USEPA, 2015a)
- *Considerations for Developing Problem Formulations for Ecological Risk Assessments Conducted at Contaminated Sites Under CERCLA* (USEPA, 2004)
- *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001a)
- *Guidance for the Data Quality Objective Process* (USEPA, 2000a)
- *Principles for Ecological Risk Assessment and Risk Management* (USEPA, 1999)
- *Guidelines for Ecological Risk Assessment* (USEPA, 1998)
- *Role of the Ecological Risk Assessment in the Baseline Risk Assessment* (USEPA, 1994)

ERAGS prescribes an eight-step process for the assessment of ecological risk to support risk management decision-making. The eight-step process includes several scientific management decision points (SMDPs) for the risk manager and risk assessment team to evaluate and approve or redirect the process (USEPA, 1997). The eight-step ERA process is conducted in a tiered-approach consisting of two phases of risk assessment:

- Screening-Level Ecological Risk Assessment (SLERA): The SLERA includes Steps 1 and 2 of the ERAGS process and represents a preliminary and conservative assessment of potential ecological risks to determine if additional steps in the ERAGS process are warranted.
- BERA: The BERA includes Steps 3 through 8 of the ERAGS process. A BERA is conducted to further characterize site-specific ecological risks and to support risk management and remedial decision-making for the protection of ecological receptors.

Roux prepared a SLERA (ERAGS Steps 1 and 2) for the Site based on data generated during the Phase I Site Characterization (Roux, 2017a). A Draft SLERA Report was submitted to the USEPA and Montana Department of Environmental Quality (MDEQ) on February 27, 2017, and comments on the Draft SLERA

Report were received from USEPA and MDEQ on April 14, 2017. A revised SLERA that incorporated USEPA and MDEQ comments was submitted on September 15, 2017 (Roux, 2017b). Based on conservative exposure assumptions, the SLERA identified constituents of potential ecological concern (COPECs) in surface water, sediment, or soil from exposure areas at the Site and concluded that there was insufficient information to dismiss potential ecological risk. The SLERA recommended further data gathering or analysis as part of a BERA to better understand ecological risk at the Site.

This BERA was conducted in accordance with final BERA Work Plan dated November 15, 2018 and approved by USEPA on November 30, 2018 (EHS Support, 2018).

Additionally, two interim deliverables describing major sub-components to the BERA Work Plan were submitted separately for review and approval by USEPA and MDEQ:

- *Technical Memorandum: Proposed Refined Ecological Screening Values (ESVs) to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site* (EHS Support, 2019a)
- *Technical Memorandum: Proposed Wildlife Exposure Modeling Approach to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site* (EHS Support, 2019b).

Comments were received and resolved on these interim deliverables prior to the completion of the BERA. The final technical memoranda are presented in **Appendix A1** and **Appendix A2**.

1.1 Purpose and Objectives

The overall purpose of the BERA is to evaluate whether environmental conditions associated with historical operations at the Site pose an unacceptable risk to ecological receptors based on the conceptual investigation framework presented in the BERA Work Plan. Specific objectives of this BERA include:

- Refine the screening-level problem formulation in the context of new information and findings of analyses conducted as part of the Phase I and Phase II Site Characterizations and the SLERA.
- Refine the ecological conceptual site model (ECSM) of the Site.
- Refine the list of COPECs identified in the SLERA to identify COPECs that are most likely to drive risk management decision-making for the Site to focus and streamline the BERA risk analysis.
- Develop screening-level and baseline ecological exposure estimates for complete exposure pathways identified in the refined ECSM for ecological exposure areas identified in the BERA Work Plan.
- Characterize risk based on baseline exposure estimates to support SMDPs for identified ecological exposure areas.
- Evaluate uncertainties in the exposure estimates and risk characterizations and the potential influence of uncertainties on risk conclusions.
- Identify potential data gaps based on the uncertainty analysis.

1.2 BERA Framework

The framework of this BERA is comprised of the following components:

- **Section 2** – Site Background, which consists of the Site and environmental settings.
- **Section 3** – Baseline Risk Assessment Problem Formulation, which includes descriptions of the nature and extent of contamination at the Site, summary of the SLERA, the ECSM, refinement of the COPECs, and assessment endpoints, risk questions, and measurement endpoints.

- **Section 4** – BERA Identification of COPECs, which includes the selection and identification of screening-level and refined COPEC lists based on the combined Phase I and Phase II Site Characterization datasets.
- **Section 5** – BERA Risk Analysis Plan, which includes key components of the effects analysis, exposure analysis, risk calculation, uncertainty analysis, and risk characterization that are investigated as part of the BERA.
- **Section 6** – Risk Characterization, which presents the results of the direct contact and wildlife ingestion evaluation of the refined COPECs.
- **Section 7** – Uncertainty Analysis, which discusses the areas of uncertainty in various components of the BERA that should be considered when interpreting the results and forming conclusions.
- **Section 8** – BERA Summary and Conclusions, which synthesizes the results of the risk characterization and uncertainty analysis to formulate a suggested strategy for further action, if warranted.
- **Section 9** – References, which lists the sources cited in this report.
- **Appendices** – Appendix files, which provide supporting information for the BERA, including:
    - Appendix A Interim Deliverables for the Baseline Ecological Risk Assessment Work Plan
    - Appendix B Screening-Level COPEC Identification Tables
    - Appendix C Calculated Dioxin Toxicity Equivalence Concentrations
    - Appendix D Calculated Ecological Screening Values for Hardness and pH Dependent Constituents
    - Appendix E Refined COPEC Identification Tables
    - Appendix F Equilibrium Partitioning Sediment Benchmark Calculations for Certain Non-ionic Organic Constituents
    - Appendix G Equilibrium Partitioning Sediment Benchmark Toxicity Units Calculations for Polycyclic Aromatic Hydrocarbons
    - Appendix H Food Chain Models for Calculating Doses to Representative Ecological Receptors
    - Appendix I ProUCL Output
    - Appendix J Incremental Soil Sampling Exposure Point Concentrations

2 Site Background

Pertinent background information for the CFAC Site is provided in this section. **Section 2.1** describes the Site setting, which includes information about the Site location and a summary of the operational history of the facility. **Section 2.2** details the environmental setting, which includes information about regional climatic conditions, localized hydrogeology, and aquatic, terrestrial, and transitional habitats identified at the Site.

2.1 Site Setting

The location and operational history of the CFAC Site is discussed in the **Sections 2.1.1** and **2.1.2**.

2.1.1 Site Location

The Site is located at 2000 Aluminum Drive in Columbia Falls, Montana (**Figure 2-1**). The Site is situated in the central portion of Flathead County, approximately 2 miles northeast of the City of Columbia Falls. The Site is accessed by Aluminum Drive via North Fork Road (County Road 486). The BERA study area consists of approximately 1,340 acres, which includes the former aluminum reduction facility and the surrounding area. The Site is generally bounded by the Cedar Creek Reservoir Overflow Ditch to the north and east, Teakettle Mountain to the east, Flathead River to the south, and Cedar Creek to the west (**Figure 2-2**).

2.1.2 Operational History

The Site was operated as a primary aluminum reduction facility (commonly referred to as an aluminum smelter) from 1955 until 2009. A detailed description of the operational history at the Site is provided in Section 2.7.2 of the RI/FS Work Plan (Roux, 2015a).

Buildings and industrial facilities remaining at the Site at the start of the Phase I Site Characterization included offices, warehouses, laboratories, mechanical shops, the Paste Plant, coal tar pitch tanks, pump houses, the Casting Garage, and the Potline Facility. The Site also includes seven closed landfills, one inactive landfill (not closed), material loading and unloading areas, two closed leachate ponds, and several wastewater percolation ponds. By January 2018, most structures on Site had been removed as part of ongoing decommissioning efforts. The structures that were removed include: West Rectifier, Rod Mill Building, Paste Plant, Quonset Hut, West Aluminum Unloader, Compressor Building, Laboratory, the Main Plant building (i.e., Pot Rooms 1 through 10), and the Change House. Several structures remain at the Site, including the administration building, the main warehouse, two ancillary warehouses, the fabrication shop, and five silos. **Figure 2-2** illustrates the locations of Site features pertinent to the BERA investigation.

2.2 Environmental Setting

The Site is situated within the Stillwater-Swan Wooded Valley ecoregion (Woods et al., 2002). Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources from a coarse (Level I) to a fine (Level IV) scale. The Stillwater-Swan Wooded Valley Level IV ecoregion is positioned west of the Canadian Rockies in the Northern Rockies area. The valley floor sits at an elevation of approximately 3,300 feet above mean sea level (ft-amsl). This section includes descriptions of the regional climatic conditions, localized hydrogeology, and descriptions of the aquatic, terrestrial, and transitional habitats present at the Site.

2.2.1 Regional Climatic Conditions

The Site is located at a latitude of 48° 23' N. The elevation of the Site ranges from approximately 3,008 ft-amsl along the Flathead River to the south to 3,270 ft-amsl at the base of Teakettle Mountain to the east. Its mid-hemisphere latitude and intermontane setting results in wide seasonal climatic swings. Average annual precipitation in the region ranges from about 14 inches to 25 inches depending on the year. Greater precipitation at higher elevations is common; much of the precipitation is stored as snow. The regional climate is considered modified maritime (i.e., much of the precipitation regime is influenced by moist air masses from the Pacific Ocean traveling from west to east). Dry, cold air masses often move in the north to south direction from Canada. The mean annual temperature for nearby Kalispell, Montana is 43.25 degrees Fahrenheit (6.25 degrees Celsius).

2.2.2 Localized Hydrogeology

The following sections describes the regional and Site-specific features that influence surface water and groundwater flow in the region and the Site.

2.2.2.1 Surface Water Hydrology and Watershed Characteristics

The Site is located within the Flathead River watershed. As discussed above, the Site is bordered by surface water features of varying hydrology on each side, including the Flathead River to the south, Cedar Creek to the west, and intermittent Cedar Creek Reservoir Overflow Ditch to the north and east (**Figure 2-2**).

The Flathead River is a tributary to the Columbia River, which flows into the Pacific Ocean. The North Fork of the Flathead River originates in the province of British Columbia, Canada. The Middle Fork of the Flathead River originates in the Bob Marshall Wilderness located south of Glacier National Park. The confluence of the North Fork and Middle Fork of the Flathead River is approximately 10 miles upstream of the Site, north of Coram, Montana. The South Fork joins the main stem of the Flathead River at the entrance of Badrock Canyon located approximately 2 miles upstream of the Site. The Flathead River flows west through Badrock Canyon towards the City of Columbia Falls where its course is then southerly toward Flathead Lake. At the Site, the drainage area of the Flathead River is approximately 4,470 square miles (mi^2), which includes the drainage area of Cedar Creek to the west.

The United States Geological Survey (USGS) maintains three gauging stations on the Flathead River in the general vicinity of the Site. The closest station is located approximately 3 miles southwest of the Site near Columbia Falls (USGS Station #12363000). Two stations are located approximately 10 miles north-northeast of the Site, i.e., the north fork station on the Flathead River and the middle fork station immediately west of Glacier National Park (USGS Stations #12355500 and #12358500, respectively). For the October 1951 to September 2016 period of record at the Columbia Falls USGS station, , the mean monthly discharge was lowest in August across that time frame with an average flow rate of 5,340 cubic feet per second (ft^3/s). Mean monthly discharge was greatest in June across that time frame with an average flow rate of 24,900 ft^3/s. The increased discharge in June corresponds to the period when average precipitation in the region is greatest. Meltwater from high elevation snowpack also contributes to the increased discharge in May and June (EHS Support, 2018). Variability in the flow rates of the Flathead River are discussed in more detail in the Phase II Data Summary Report (DSR) (Roux, 2019).

Cedar Creek originates north of the Site in the area contributing to the Cedar Creek Reservoir. At the outlet of the Cedar Creek Reservoir, the upgradient catchment area is 12.5 mi^2. From the reservoir outlet, Cedar Creek flows approximately 3 miles southwest towards the City of Columbia Falls. The elevation of Cedar Creek is higher than groundwater elevations within the Site, indicating that Cedar Creek is a losing stream rather than a gaining stream. According to the USGS National Hydrography Dataset (NHD), a tributary to Cedar Creek is mapped that bisects the northern area of the Site. This intermittent feature is shown to be situated along the eastern side of the Industrial Landfill and joins Cedar Creek approximately 0.5 mile to the southwest of the Industrial Landfill. This feature was not observed during Site investigation activities; however, surface water ponding and wetland vegetation were observed in the area south and southeast of the Industrial Landfill. Based on field observations, the source of the ponding was attributed to seeps in the nearby cliff. This feature was generally mapped by Roux field personnel and is identified on **Figure 2-2** as the Northern Surface Water Feature. At the western Site boundary, Cedar Creek drains an additional 1.5 mi^2, predominately from the western two-thirds of the Site.

The Cedar Creek Reservoir Overflow Ditch flows intermittently in the spring and regulates flow for Cedar Creek and the Cedar Creek Reservoir (Hydrometrics, 1985). Based upon proximity and land surface topography, some surface water runoff from the eastern side of the Site, originating from the East Landfill and the Sanitary Landfill, as well as runoff from the western flank of Teakettle Mountain, flows to the Cedar Creek Reservoir Overflow (**Figure 2-2**). Excluding potential upgradient contributions from the Cedar Creek Reservoir, the Cedar Creek Reservoir Overflow has a catchment area of approximately 2.0 mi^2. About 20 percent of this catchment area originates on-site and the remaining catchment extends to the peak of Teakettle Mountain to the east. Like Cedar Creek, the elevation of Cedar Creek Reservoir Overflow is higher than surrounding groundwater elevations within the Site, indicating that the Cedar Creek Reservoir Overflow drainage is a losing stream.

2.2.2.2 Site Hydrogeological Units

The stratigraphic units underlying the Site form a complex hydrogeologic framework that influences groundwater elevations, groundwater flow, and the migration of constituents of potential concern (COPCs) beneath the Site. Three major stratigraphic units were identified during the Phase I Site Characterization and are described in the *Phase I Site Characterization Data Summary Report* (Phase I DSR; Roux, 2017a). The three stratigraphic units consist primarily, from land surface down, of:

- Layer of glaciofluvial and alluvial coarse-grained soils, varying in vertical extent and grain size depending on the vicinity to the Site features (i.e., Teakettle Mountain, Flathead River)
- Layer of dense, poorly-sorted glacial till with interbedded deposits of glaciolacustrine clays and silts
- Bedrock

The coarse-grained glacial outwash and alluvium deposits that are found above the glacial till are collectively referred to as the “upper hydrogeologic unit” at the Site (Roux, 2017c). The coarse-grained glacial deposits that comprise the upper hydrogeologic unit account for the main water bearing unit beneath the Site. The glacial tills found below the upper hydrogeologic unit were typically characterized as containing a higher percentage of fines that were denser and drier than the overlying outwash and alluvium deposits. The till deposits were often characterized as stiff and moist or dry. These observations indicate that the till deposits likely have a lower hydraulic conductivity than the overlying outwash and alluvium deposits in the upper hydrogeologic unit. The bedrock beneath the till has metamorphosed over time, resulting in a tightly compacted, low porosity and low permeability unit. Based upon the conceptual site model, bedrock is considered to define the bottom of the hydrogeologic system beneath the Site.

2.2.2.3 Groundwater Occurrence and Flow

Groundwater flow in the region tends to follow surface topography (USEPA, 2011). Groundwater is typically recharged from direct infiltration and surface water sources, which include reservoirs, ponds, streams, and lakes (LaFave et al., 2004). Groundwater in the region may also discharge to surface water bodies, depending on the season and localized conditions.

Groundwater occurrence and movement was evaluated during the Phase I Site Characterization described in the Phase I DSR (Roux, 2017a) and the *Groundwater and Surface Water Data Summary Report* (Roux, 2017c), and during the Phase II Site Characterization described in the Phase II DSR (Roux, 2019). During the Phase I Site Characterization, 64 monitoring wells were visited on the following dates to measure depth to groundwater across the Site: August 30, 2016; November 29, 2016; March 14-15, 2017; and June 16, 2017. During the Phase II Site Characterization, 77 monitoring wells (including 8 newly installed monitoring wells and 5 former production wells) were visited on June 4-5, 2018 and October 1-2, 2018, to measure depth to groundwater across the Site. Pressure transducers were also installed in selected wells to monitor groundwater elevations throughout the Phase I and Phase II Site Characterization. The elevation data collected from gauging and from the pressure transducers indicate that groundwater elevations fluctuate seasonally at varying magnitudes depending on the area of the Site, and the hydrogeologic unit where the well is screened. Additionally, groundwater elevations measured in monitoring well clusters, where there is a well screened within the upper hydrogeologic unit and an adjacent deep well screened below the upper hydrogeologic unit, indicates a downward vertical gradient exists. However, the differences in elevations between the glacial till and the upper hydrogeologic unit is typically greater than 25 feet, and in some cases exceeds 50 feet. This large difference is indicative of limited (if any) hydraulic connectivity between the two water bearing zones.

Groundwater flow across the Site in the upper hydrogeologic unit is generally in the south-southwest direction towards the Flathead River. While the southerly flow direction is consistent across the Site, the discussion of the hydraulic gradient can be divided into three distinct areas:

- Near Teakettle Mountain and in the landfill area of the Site, the groundwater hydraulic gradient is steep (approximately 0.059 ft/ft [1 foot by 1 foot cross-sectional gradient of groundwater, ft/ft]) and generally mirrors the steeper topography in that portion of the Site.
- Groundwater elevations in the center of the Site (near the North Percolation Ponds, former Operational Area, and northern half of the Main Plant Area) are consistent over long distances (typically within 1 foot over distances greater than 1,000 feet), indicating a relatively flat groundwater hydraulic gradient (approximately 0.0045 ft/ft) across the center of the Site.
- The gradient then increases in the southern area of the Site between the Main Plant Area and the Flathead River (approximately 0.031 ft/ft), which is also consistent with the steep drop in topography between the railroad and the Flathead River.

The gradients above and the elevations measured in the Flathead River generally indicate that the groundwater in the upper hydrogeologic unit appears to discharge to the Flathead River.

2.2.3 Description of Aquatic, Terrestrial, and Transitional Habitats

Aquatic, terrestrial, and transitional habitats are present within the Site. This section describes the general physical, hydrological, or vegetative characteristics of habitats within the Stillwater Swan Wooded Valley ecoregion where the Site is located in Montana (Woods et al., 2002). The habitat types described for the Site are used as the basis for identifying ecological exposure areas for the BERA (**Section 3.3.1**).

Aquatic habitats are characterized by perennial or near-perennial inundation with water and physical habitats that can support aquatic receptor species. In lotic aquatic habitats (flowing streams and rivers), flow conditions are suitable for the establishment of fish and invertebrate communities, as well as semi-aquatic birds or mammals that rely on aquatic flora or fauna as a food resource. Two lotic aquatic habitats exist within and around the Site, including the Flathead River and Cedar Creek. The Flathead River is considered a large river by the MDEQ. Large rivers are non-wadeable and almost always seventh-order or higher according to the Strahler stream order index (Strahler, 1964). Key physical habitat features of the Flathead River include cobble or gravel substrate; deep, fast-flowing water; and, depending on valley dimensions, multi-thread channels. In the river reach adjacent to the Site, the Flathead River provides marginal fish habitat for common species, with this section of the river being used as a migration corridor to access areas of more suitable habitat (Stagliano, 2015). Given the absence of extensive agriculture or other non-anthropogenic nutrient sources upgradient, the Flathead River is considered oligotrophic, which means that it lacks macronutrients, such as phosphorus.

Cedar Creek is a small headwater stream that discharges to the Flathead River. Small headwater stream habitats in the region can be distinguished primarily by their hydrologic regime. Montane headwater streams that originate in the high-elevation peaks have characteristically high spring and early summer flows, with the spring freshet due to snow melt. Small headwater systems are also often oligotrophic.

Terrestrial habitats are dry, upland areas that may support aboveground and/or belowground terrestrial flora and fauna. Soils that are considered terrestrial habitat are limited to the vadose, or unsaturated, zone of the soil profile. Vegetation type is another key characteristic of physical terrestrial habitats. There are four primary terrestrial habitats on the Site, which are characterized predominately by the type of vegetation present. These habitats include mixed conifer forest, riparian forest, deciduous shrubland, and open grassland. Detailed descriptions of each terrestrial habitat type and associated flora and fauna are provided in the SLERA (Roux, 2017b).

Transitional habitats are characterized by intermittent or seasonal surface water inundation. Transitional habitats can potentially support aquatic receptor species during certain life stages (e.g., benthic invertebrates, juvenile herpetofauna), as well as terrestrial species during dry periods (e.g., soil invertebrates, terrestrial plants).

Ecological exposure areas identified based on on-site habitat types are defined in **Section 3.3.1**. The evaluation of potential ecological receptors within exposure areas is distinguished based on the presence of aquatic, terrestrial, or transitional habitat characteristics.

3 Baseline Risk Assessment Problem Formulation

The purpose of the baseline problem formulation is to re-evaluate the screening-level problem formulation in the context of new information and findings of analyses conducted as part of the ongoing investigation at the Site. The baseline problem formulation establishes risk assessment goals, characterizes ecological effects of primary COPECs, and updates the preliminary ECSM. The refined ECSM is used to define assessment endpoints, risk questions, and measurement endpoints to guide the development of the conceptual BERA study design. The following sections present the preliminary baseline problem formulation that was previously presented in the SLERA (Roux , 2017b) and Phase I Site Characterization (Roux, 2017a). Any additions or modifications of the preliminary baseline problem formulation based on the review of the Phase II data are incorporated in the individual components of the problem formulation described below.

3.1 Nature and Extent of Contamination

In 2013, Weston Solutions, Inc. (Weston) completed an investigation at the Site on behalf of USEPA Region 8. The results were summarized in the April 2014 report titled *Site Reassessment for Columbia Falls Aluminum Company Aluminum Smelter Facility, Columbia Falls, Flathead County, Montana prepared for United States Environmental Protection Agency Region 8* (Weston, 2014). As part of the investigation, a total of 68 groundwater, surface water, sediment, and soil samples were collected at the Site. Results were used by the USEPA to establish if an observed release had occurred at the Site as that term is defined in the USEPA Hazardous Ranking System Guidance Manual. The data collected during the Weston investigation was considered when developing the Scope of Work for the Phase I Site Characterization that was completed by Roux, on behalf of CFAC, in 2016 and 2017.

The Phase I Site Characterization program was designed to identify and/or confirm source areas and broadly characterize the nature and extent of associated constituents of concern across the Site and around Site features. Based on the preliminary conceptual site model (CSM) presented in the RI/FS Work Plan, the nature and extent of contamination was evaluated from the following site features identified as potential source areas (**Figure 2-2**):

- Landfills (including the closed Wet Scrubber Sludge Pond and the closed leachate ponds)
- Former Drum Storage Area
- Percolation ponds
- Waste and raw materials storage and handling areas
- Plant drainage system including drywells and associated discharge points
- Underground storage tanks (USTs) and aboveground storage tanks (ASTs)

The results of the Phase I Site Characterization indicated that cyanide, fluoride, and polycyclic aromatic hydrocarbons (PAHs) are the primary COPCs identified within the potential source areas and Site features (Roux, 2017a). A summary of key findings regarding the nature and extent of constituents as it relates to the baseline problem formulation include:

- Elevated[1] cyanide and fluoride concentrations in groundwater within the upper hydrogeologic unit appear to originate immediately to the west of the Wet Scrubber Sludge Pond, with maximum concentrations immediately downgradient of the West Landfill and Wet Scrubber

[1] The term “elevated” refers to concentrations that are considered to be high relative to a benchmark value, background statistic, etc.

Sludge Pond. The Center Landfill also appears to be a source of cyanide and fluoride in groundwater. Cyanide and fluoride concentrations in groundwater to the east and northeast of these site features, and downgradient of other site landfills, are generally orders of magnitude lower.

- Soils adjacent to the West Landfill contained elevated concentrations of cyanide, fluoride, and PAHs.
- Elevated cyanide and fluoride concentrations were observed in soil and groundwater in the Former Drum Storage Area, located immediately to the west of the Wet Scrubber Sludge Pond and West Landfill.
- Concentrations of PAHs and cyanide in the percolation ponds were typically greatest in soil and sediment in the North-East Percolation Pond and its influent ditch, followed by the effluent ditch, North-West Percolation Pond, and West Percolation Pond; concentrations of COPCs decreased with increasing depth in the percolation ponds.
- COPCs detected in soil and sediment in the South Percolation Ponds were similar to the other percolation ponds, but concentrations were generally much lower than the other ponds.
- Cyanide, fluoride, and PAHs were the primary COPCs detected in soils throughout the Main Plant Area.
- Low level detections of benzene, toluene, ethylbenzene, and xylene (BTEX) were the primary volatile organic compounds (VOCs) in soils across the Site. The presence of BTEX may be related to petroleum coke and pitch materials used at the Site.
- The Phase I Site Characterization found that naturally-occurring metals were detected in soil and sediment samples across the Site. A comprehensive evaluation of Phase I and Phase II concentrations in Site data compared to background concentrations was performed in the DSR Report (Roux, 2019) and within this BERA as part of the COPEC refinement step (please see Sections 3.6.4 and 4.4.2 for additional details). This analysis was used to identify which metals (and some organic constituents with widespread anthropogenic sources) are consistent with background concentrations, as compared to constituents that may be present as a result of site operations.
- Pesticides were not detected in any soil samples collected during the Phase I Site Characterization; however, mean and median method detection limits (MDLs) for some pesticides exceeded the lowest screening criteria.
- Polychlorinated biphenyls (PCBs) were not detected in discrete samples in the site-wide soil dataset; however, PCBs were detected in four decision units (DUs) within the central portion of the Operation Area.
- Consistent with the preliminary CSM, soil and groundwater results from the Phase I Site Characterization indicate low potential for soil vapor exposure based on low VOC concentrations detected in soil and groundwater.

The findings from the Phase II Site Characterization sampling effort (Roux, 2019) were generally similar to the Phase I Site Characterization (Roux, 2017a):

- Cyanide, fluoride, and PAHs are primary COPCs in soil at the Site. The Site-wide soil quality observed during the Phase II Site Characterization is consistent with the findings of the Phase I Site Characterization. The highest concentrations of these COPCs in soil were generally found in the industrial areas of the Site including the Main Plant and Operational Area, the North Percolation Ponds, and the Central Landfill Area.
- The results of the background sampling from the Phase II Site Characterization and statistical data analysis indicate that many of the metal concentrations observed in soil samples are likely

a result of metals present at background concentrations. However, some of the areal distribution of metal detections and the magnitude of metal concentrations around certain Site features may also be a result of the former Site operations.

- Dioxin and furan compounds were detected in all soil samples collected during the Phase I Site Characterization and Phase II Site Characterization. Concentrations were highest within or adjacent to the Rectifier Yards (immediately south and northeast) but not at locations within the remainder of Main Plant Area or in the Western Undeveloped Area. Low concentrations of dioxin and furan compounds are wide-spread and are present at similar concentrations in the Western Undeveloped Area and the background reference locations.
- PCBs were detected in some soil samples, primarily in locations just south of the Wet Scrubber Sludge Pond; however, PCBs are not widespread in Site-wide soils.
- VOCs were frequently detected in soil samples across the Site. The widespread distribution of petroleum VOCs across the Site is somewhat similar to that of PAHs. The frequent detection of petroleum-related VOCs at trace levels in soil is likely attributed to the presence of these VOCs, albeit at low concentrations, in the petroleum coke and pitch materials that were used in manufacturing at the Site and were the primary sources of PAHs at the Site.
- Concentrations of cyanide and fluoride measured in Backwater Seep Sampling Area and the South Percolation Ponds were consistent with the suspected areas where groundwater is expressed from the upper hydrogeologic unit.
- Surface water sampling confirmed that many naturally occurring metals were detected frequently in surface water samples. Concentrations exceeding screening values were most commonly observed in the North and South Percolation Ponds and Flathead Riparian Area Channel.
- Semi-volatile organic compounds (SVOCs) (primarily PAHs) were detected in surface water samples, but not were not observed at elevated concentrations.
- Cyanide, fluoride, and PAHs in sediment samples were detected most frequently in the Backwater Seep Sampling Area, Flathead Riparian Area Channel, and North and South Percolation Ponds. Cyanide concentrations exceeded the USEPA Residential regional screening level (RSL) in five sediment samples, including sediment samples within and west of the Backwater Seep Sampling Area, the western most South Percolation Pond, and the North-East Percolation Pond. PAHs were most frequently detected in the North Percolation Ponds, the Backwater Seep Sampling Area, and the South Percolation Ponds.
- Similar to site-wide sediment and surface water quality data, cyanide and fluoride were detected most frequently and at the highest concentrations in sediment pore water samples in the Backwater Seep Sampling Area, Flathead Riparian Area Channel, and South Percolation Ponds. Cyanide concentrations in pore water which exceeded the DEQ-7 Acute Aquatic Life Standard occurred in the Backwater Seep Sampling Area, Flathead Riparian Area Channel, and the South Percolation Ponds. Fourteen different dissolved metals were detected in sediment pore water during the Site Characterization.
- The comparison of background and site surface water analytical data indicated that total cyanide, free cyanide, fluoride, select total and dissolved metals, and select PAHs in surface water are potentially Site-related within most or all (depending on the analyte and feature) of the surface water features.

3.2 Summary of Screening-Level Ecological Risk Assessment

The initial SLERA that was performed using the results of the Phase I Site Characterization (Roux, 2017a) provided a preliminary assessment of potential risks to ecological receptors that may be exposed to Site constituents in soil, surface water, and sediment (Roux, 2017b). It should be noted that all steps of the initial SLERA were revisited in this BERA following the collection and analysis of the Phase II data (**Section 4**). The SLERA problem formulation included a preliminary ECSM that was developed for aquatic and terrestrial exposure areas. The preliminary ECSM described potential sources of constituents, release mechanisms, exposure media, representative receptor groups, and the complete exposure pathways for each receptor/medium combination.

Based on the review of the historical processes and data collected during the SLERA, COPECs were identified in surface water, sediment, and surface soil to which ecological receptors could potentially be exposed (Roux, 2017b). COPECs were identified in the exposure analysis presented in the SLERA, which assumed maximum exposure scenarios based on comparisons of maximum exposure point concentrations to the most conservative ecological screening values (ESVs) (i.e., the minimum ESV) from a list of screening criteria sources developed in discussions with USEPA. The conservative assumptions of the SLERA exposure analysis could not be used to conclude that unacceptable risk does not exist. Rather, the findings of the exposure analysis indicated that certain COPECs and associated exposure pathways require further evaluation.

Based on these results, the SLERA concluded that there was a potential for adverse ecological effects and a more thorough assessment was warranted (USEPA, 1997). Given the uncertainties in the exposure analysis described above, it was recommended that the ecological risk assessment process proceed to ERAGS Step 3 (Baseline Risk Assessment Problem Formulation). The following section presents a refined ECSM based on the SLERA and additional information developed since the submittal of the SLERA.

3.3 Ecological Conceptual Site Model

Based on the findings of the SLERA (Roux, 2017b) and Phase I and II Site Characterizations (Roux, 2017a and 2019, respectively), the preliminary ECSM developed in the SLERA was refined to incorporate new information fundamental to the design of additional data collection activities to support the BERA. Key elements of the preliminary ECSM that were refined in the BERA problem formulation include:

- Exposure areas: Ecological exposure areas were re-defined based on the outcome of the SLERA to represent the habitat types (aquatic, transitional, and terrestrial) and receptor groups that may be present and exposed to site constituents.
- Ecological receptor categories: Additional ecological receptor categories and representative receptor species, including updated queries of special status species (e.g., rare, threatened, and endangered species), were identified in the refined ECSM.
- Exposure pathways: Potential exposure pathways were re-evaluated based on the SLERA findings to assess fate and transport properties of COPECs that may influence mobility and/or exposure routes to receptor categories.
- Bioavailability: The refined ECSM includes an evaluation of the site characteristics that may influence the bioavailability of primary COPECs in site exposure media.
- Bioaccumulation/biomagnification: The relative importance of COPECs that bioaccumulate or biomagnify were evaluated in the refined ECSM to identify potential data gaps that may be addressed in the BERA.

The following sections present the refined ECSM for the BERA problem formulation.

3.3.1 Ecological Exposure Areas

Ecological exposure areas presented in the SLERA were refined to represent primary habitat types and receptor groups that may be exposed to site constituents. Ecological exposure areas were grouped into three broad categories based on habitat types:

- Terrestrial Exposure Areas
- Transitional Exposure Areas
- Aquatic Exposure Areas

The following sections describe the categories of ecological exposure areas identified for the BERA problem formulation. The spatial extents of ecological exposure areas are illustrated in **Figure 3-1**.

3.3.1.1 Terrestrial Exposure Areas

Terrestrial exposure areas consist of upland habitats and include the following (**Figure 3-1**):

- Main Plant Area (231.9 acres)
- Central Landfills Area (91.4 acres)
- Industrial Landfill Area (12.6 acres)
- Eastern Undeveloped Area (32.1 acres)
- North-Central Undeveloped Area (114.4 acres)
- Western Undeveloped Area (439.6 acres)
- Flathead River Riparian Area (93.9 acres)

The primary habitat types within the terrestrial exposure areas include mixed conifer forest, riparian forest, deciduous shrubland, and open grassland. Conifer forests are predominantly found to the north and west of the Main Plant Area and are mostly bordered by riparian woodlands. Several areas of deciduous shrubland are located northeast and east of the Main Plant Area. Open grasslands are located immediately north and west of the Main Plant Area, between the Main Plant Area and the mixed conifer and riparian forests.

Site-related constituents from features identified as potential source areas may be present in environmental media, specifically soil, in the terrestrial exposure areas. Current primary constituent migration pathways from potential source areas to terrestrial exposure areas may include overland stormwater runoff associated with precipitation or snowmelt events. Historically, atmospheric deposition was also a potential constituent migration pathway from site emission sources. Habitats within the terrestrial exposure areas may support multiple receptor groups, including terrestrial plants, soil invertebrates, herptiles, birds, and mammals. Terrestrial exposure areas do not provide aquatic or transitional habitats, and therefore, do not support aquatic receptors. Receptors may use the terrestrial exposure areas for foraging and reproduction. The ecological relevance of these habitats may vary among the terrestrial exposure areas based on the degree of historical site operations and infrastructure, such as buildings and impervious surfaces. For example, developed areas within the Main Plant Area and Central Landfills Area provide limited habitat value for terrestrial receptors under current exposure conditions due to disturbances related to site activities.

3.3.1.2 Transitional Exposure Areas

Transitional exposure areas consist of intermittently- or seasonally-wetted habitats and include the following (**Figure 3-1**):

- North Percolation Pond Area (11.3 acres)
- South Percolation Pond Area (5.6 acres)
- Cedar Creek Reservoir Overflow Ditch (5.2 acres)
- Northern Surface Water Feature (6.1 acres)

Site-related constituents from features identified as potential source areas may be present in environmental media, including soil, surface water, sediment, and pore water in the transitional exposure areas. Primary constituent migration pathways from potential source areas to the transitional exposure areas may include overland stormwater runoff associated with precipitation or snowmelt events and direct discharges of stormwater and formerly wastewater (e.g., North and South Percolation Pond Areas). Habitats provided by transitional exposure areas range from aquatic to terrestrial depending on seasonal climatic and hydrogeologic conditions and may also range in quality depending on historical site operations. For instance, the North Percolation Ponds were constructed for wastewater management and were not designed to provide wildlife habitat. Therefore, the North Percolation Ponds may support lesser numbers of the aquatic and terrestrial receptor groups identified in **Section 3.3.5**due to the marginal habitat conditions available. Based on the intermittent nature of aquatic habitats in these transitional exposure areas, it is unlikely that permanent aquatic communities would be established. These areas may be important for the reproduction of amphibians and may also provide drinking water sources for terrestrial receptors during wet periods of the year.

3.3.1.3 Aquatic Exposure Areas

Aquatic exposure areas consist of perennially-wetted habitats and include the Flathead River Area and Cedar Creek Area (**Figure 3-1**). These exposure areas are located on the borders of the Site to the south and northwest, respectively. Site-related constituents from features identified as potential source areas may be present in environmental media, including surface water, sediment, and pore water in the aquatic exposure areas. Primary constituent migration pathways from potential source areas to the aquatic exposure areas may include groundwater discharge to surface water and overland stormwater runoff associated with precipitation or snowmelt events. Habitats within the aquatic exposure areas may support multiple aquatic receptor groups, including aquatic plants, benthic invertebrates, fish, herptiles, and semi-aquatic birds and mammals. These receptor groups may use the aquatic exposure areas for foraging and reproduction. In addition to aquatic receptors, aquatic exposure areas may also provide drinking water sources for terrestrial receptors, such as herptiles, birds, and mammals.

3.3.2 Source Areas

Based on the preliminary CSM presented in the RI/FS Work Plan (Roux, 2015a) and updated in the Phase I and Phase II DSRs, the nature and extent of contamination was evaluated from the following site features that were identified as potential source areas:

- Landfills (including the closed Wet Scrubber Sludge Pond and the closed leachate ponds)
- Former Drum Storage Area
- Percolation ponds
- Waste and raw materials storage and handling areas

- Plant drainage system including drywells and associated discharge points
- USTs and ASTs

The potential source areas associated with each ecological exposure area were identified in the refined ECSM, as presented in **Figure 3-2** for terrestrial exposure areas, **Figure 3-3** for transitional exposure areas, and **Figure 3-4** for aquatic exposure areas.

3.3.3 Fate and Transport Pathways

The fate and transport of site-related constituents released into the environment depends on the physicochemical properties of the constituent and environmental media, and the physical characteristics of the migration pathway. Constituents may partition in various environmental media, such as surface water, sediment, and soil, which affects the potential ecological risks posed to aquatic and terrestrial receptors. The primary constituent migration pathways, from the site features identified as potential source areas presented in **Section 3.3.2** to the ecological exposure areas described in **Section 3.3.1,** may include groundwater discharge to surface water, overland stormwater runoff associated with precipitation or snowmelt events, direct discharges of stormwater and formerly wastewater, and historically, atmospheric deposition from site emission sources.

Groundwater discharge to surface water occurs in the Flathead River. Groundwater from the upper hydrogeologic unit beneath the Site is not known to discharge to surface water in any other aquatic or transitional exposure areas. Groundwater elevations are lower than the elevations of Cedar Creek and the Cedar Creek Reservoir Overflow Ditch; therefore, these systems are considered to be losing systems with surface water recharging groundwater. The Northern Surface Water Feature is an intermittent feature that appears to be fed by seeps located to the north and west. Snowmelt and increased seasonal precipitation create an elevated water table, which feeds these seeps in the Northern Surface Water Feature in the spring.

Shallow groundwater from the upper hydrogeologic unit beneath the Site discharges to the Flathead River. A groundwater seep has been identified along the Flathead River in the Backwater Seep Sampling Area of the Site (**Figure 2-2**). Cyanide and fluoride are the primary constituents of concern identified in the groundwater seep. The discharge of cyanide and fluoride in groundwater to the Flathead River adjacent to the Site has been authorized by Montana Pollutant Discharge Elimination System (MPDES) permit number MT-0030066 since first issued in May 1994, and subsequently renewed in 1999 and July 2014. On January 24, 2019, MDEQ provided a Notice of Intent to terminate the permit. In the Statement of Basis that accompanied the 1999 MPDES Permit No. MT-00330066, MDEQ noted the following (MDEQ):

- Cyanide is not persistent in surface water due to photo-degradation and volatilization
- The mixing zones provided for in the permit would have no effect on fish migration in the Flathead River
- There are no spawning or nursery areas, no effects to fish migration, and no evidence of attraction to the cyanide concentration in the acute mixing zone backwater channel, and;
- There was no anticipated impact on aquatic species or other species.

Constituents in groundwater discharged to surface water may remain in dissolved form, adsorb to suspended particulates, or partition to fine-grained sediments within the receiving exposure areas. Cyanide and metal-cyanide anions, as well as dissolved metals, may adsorb to oxide minerals or clays with high anion exchange capacities, which may influence their bioavailability and potential ecological risks posed to ecological receptors.

Overland stormwater runoff associated with precipitation or snowmelt events is another potential constituent migration pathway from site features identified as potential source areas to ecological exposure areas. Stormwater may transport constituents in dissolved form or adsorbed to suspended sediment or soil particles. Dissolved forms are subject to the processes described above, while constituents adsorbed to soil or sediment particles being transported by stormwater will eventually settle in depositional areas of the given ecological exposure area, whether aquatic, transitional, or terrestrial. The age of constituents within soils also affects the fate and transport processes described above. The likelihood of dissolved-phase transport and bioavailability often decreases with increased time since the constituent entered the soil. Smolders et al. (2009) evaluated 10 percent inhibition endpoints for plants, soil invertebrates, and microbial processes exposed to metals in aged versus freshly contaminated soils. The findings of the evaluation indicated that total soil metal concentrations resulting in 10 percent inhibition endpoints in freshly amended soils were up to 100-fold lower than total soil metal concentrations resulting in 10 percent inhibition in aged or field-contaminated soils (Smolders et al., 2009).

Several transitional exposure areas received direct wastewater and stormwater discharges from historical Site operations, including the North Percolation Pond Area and South Percolation Pond Area. Although wastewater is no longer discharged to these exposure areas, the site stormwater conveyance system still discharges to these exposure areas. Stormwater may transport site-related constituents, including aluminum, cyanide, and fluoride, as previously described.

3.3.4 Exposure Media and Exposure Pathways

The Phase I and Phase II Site Characterization Data Summary Reports indicated that site-related constituents are present in environmental media at the Site (Roux, 2017a and 2019). The type(s) of impacted environmental media varies among the different ecological exposure areas and associated habitats, and may include surface water, sediment (including pore water), and soil. Ecological receptor exposure pathways to constituents within the impacted environmental media include ingestion (direct and incidental), and to a lesser extent (based on the COPECs identified), direct contact and inhalation. The exposure media and pathways identified in the refined ECSM are presented in **Figure 3-2** for terrestrial exposure areas, **Figure 3-3** for transitional exposure areas, and **Figure 3-4** for aquatic exposure areas.

3.3.4.1 Direct Contact

Direct contact is considered a complete exposure pathway for select aquatic and terrestrial receptors (including plants, invertebrates, fish, and amphibians) that may be exposed to constituents in sediment and surface water through direct contact via absorption through plant tissue, gills, or skin. Select terrestrial receptors (including plants and soil invertebrates) may be exposed to constituents in surficial soil through direct contact via absorption through plant tissue or skin. Other semi-aquatic and terrestrial receptors may be exposed to constituents in surface water, sediment, or soil through direct contact; however, this exposure pathway is considered secondary to ingestion pathways for these receptors. Dermal contact exposure pathways to birds and mammals are not considered significant exposure pathways due to the presence of fur on mammals, feathers on birds, and scales on reptiles that mitigate direct dermal exposure (USEPA, 2005b). Therefore, the direct contact exposure pathway was only evaluated quantitatively for plants, invertebrates, fish, and amphibians (**Figures 3-2** through **3-4**).

3.3.4.2 Ingestion – Direct and Indirect

Ingestion of impacted environmental media, including direct ingestion of dietary items and surface water and indirect ingestion of sediment and soil, is the primary exposure pathway of concern for most upper trophic aquatic and terrestrial receptors. Direct ingestion of dietary items may be an important exposure pathway if environmental media are impacted by persistent, bioaccumulative constituents. Persistent, bioaccumulative constituents in sediment, surface water, and soil may be assimilated by lower trophic level species, bioaccumulated in tissues, and transferred to higher trophic level species that consume lower trophic level species.

Exposure through ingestion pathways varies based on the foraging habits and ranges of the receptor. For instance, some receptors have small home ranges and forage within a localized area for their entire lifetime, while others, such as migratory receptors, may only forage in a specific area for a brief period before leaving to forage elsewhere. Incidental ingestion of impacted environmental media, such as soil or sediment, while grooming or foraging may also occur, but is considered secondary to the direct ingestion pathway.

3.3.4.3 Inhalation

Inhalation is a potentially complete, but secondary exposure pathway for terrestrial receptors. This exposure pathway may include the inhalation of constituents that have volatilized, or that are adsorbed to airborne particulates. Burrowing animals may be exposed to constituents through inhalation pathways while occupying burrows. Inhalation exposure pathways may be related to the inhalation of VOCs in soil vapor or soil dust particles within the burrow. Based on the SLERA and other Phase I Site Characterization data, VOCs were infrequently detected and not identified as COPCs in soils from terrestrial exposure areas where burrowing mammals may be present. Therefore, it is not likely that exposure to VOCs in subsurface soil vapor contributes significantly to the risk to potential burrowing animals at the Site. Burrowing animals may also be exposed to constituents sorbed to respirable dust particles that may be inhaled while occupying burrows. However, the inhalation of respirable dust is likely to have a minor contribution to overall risk. Based on exposure to humans, inhalation of respirable dust particles represents a relatively insignificant portion of the total exposure (i.e., less than 5 percent; USEPA, 2005b). Inhalation pathways likely result in negligible contributions to overall exposure relative to ingestion pathways; therefore, inhalation exposures were not evaluated quantitatively in the BERA.

3.3.5 *Hydrologic Variability and Spatial and Temporal Trends in Surface Water Cyanide and Fluoride*

The Phase II Sampling and Analysis Plan (SAP) (Roux, 2018a) evaluated hydrologic variability in conjunction with spatial and temporal trends of surface water cyanide and fluoride concentrations. This assessment used long-term records of stream discharge measurements from the Flathead River, precipitation data from Kalispell Airport, and analytical results from the Phase I Site Characterization (Roux, 2017a) to elucidate how temporal variations in hydrologic condition may influence subsequent investigations of cyanide and fluoride in aquatic exposure areas of the Flathead River and its adjacent riparian zone. A summary of key findings from the Phase II SAP assessment (Roux, 2018a) are discussed below. Additional findings for the complete Phase I and Phase II Site Characterization datasets are presented in **Section 4.1.2** and in **Section 6.3.1**.

The assessment of discharge data from the Flathead River indicated that average monthly discharge patterns for 2016 and 2017 were generally consistent with the 10-year monthly discharge pattern from 2008 to 2017 (Roux, 2018a). Over the 10-year period, maximum discharges typically occurred in May and June and minimum discharges were noted between October and March. During Phase I Site Characterization sampling in 2016 and 2017, maximum and minimum discharge events occurred within a representative time frame that is consistent with historical data (**Figure 3-5**). The 2016 Phase I sampling period was characterized by a lower than average monthly discharge, except for October and November. In 2017, monthly discharge was higher than average. In addition, the 2017 discharge within the Flathead River had greater extremes in both maximum and minimum monthly discharge than the 10-year average.

Spatial and temporal trends were observed in surface water fluoride and cyanide collected during the Phase I Site Characterization (Roux, 2017a). The BERA Work Plan (EHS Support, 2018) further discussed the temporal variability and spatial gradient in surface water fluoride and total cyanide concentrations in the Backwater Seep Sampling Area and downstream stations in the Flathead River over the four Phase I sampling events. Spatial and temporal trends noted in the Phase II SAP and BERA Work Plan are discussed below.

Spatial trends observed followed the general pattern of elevated concentrations of cyanide and fluoride in the Backwater Seep Sampling Area, which exhibited attenuation in the downstream direction. Concentrations in samples collected from the downstream portion of the Flathead River, outside of the Backwater Seep Sampling Area, rapidly reached undetectable levels immediately downgradient of the seep area itself. The greatest surface water concentrations of total cyanide and fluoride were generally observed at station CFSWP-005. During all sampling rounds of the Phase I investigation, surface water concentrations of total cyanide and fluoride decreased with increasing distance downstream.

Temporal trends were associated with flow condition in the Flathead River. Wet periods of high discharge were characterized by lower concentrations of cyanide and fluoride, with the opposite observed during low water. The greatest surface water concentrations of total cyanide and fluoride were generally observed at station CFSWP-005 when discharge in the Flathead River was low (Phase I – Round 1 and Round 2). Surface water concentrations at CFSWP-005 decreased for fluoride and to a lesser extent during high-water sampling events (Phase I – Round 3 and Round 4). This evaluation suggested that potential exposure to total cyanide and fluoride in surface water in the Backwater Seep Sampling Area was greatest during low-flow sampling events in the Flathead River (September through December). Temporal patterns also seemed to influence the relative decrease in surface water concentrations moving downstream suggesting that interactions between flow magnitude and position was occurring. Rapid attenuation with distance was noted, particularly for cyanide, which was non-detect in sample stations within the Flathead River itself. These interaction effects were explored as part of this investigation and discussed in greater detail in **Section 4.1.2** and in **Section 6.3.1** for the complete Phase I and Phase II Site Characterization datasets.

The temporal evaluation of total cyanide and fluoride concentrations in Phase I surface water samples from other aquatic and transitional exposure areas of the Site indicated some seasonal variability in fluoride concentrations. However, variability in total cyanide concentrations did not indicate a clear seasonal pattern due to the low concentrations that were observed.

3.3.6 Ecological Receptors of Concern

The ecological exposure areas identified in **Section 3.3.1** may support multiple ecological receptors of concern. Aquatic receptors of concern that may use habitats within aquatic and/or transitional exposure areas include plants, invertebrates, fish, herptiles, and semi-aquatic birds and mammals. Terrestrial receptors of concern that may use habitats within aquatic, transitional, and/or terrestrial exposure areas include plants, invertebrates, herptiles, and terrestrial birds and mammals.

Several surrogate species were identified as representative species to evaluate exposure to mammalian and avian receptors based on feeding guild. Representative terrestrial species for each receptor group based on feeding guild are provided below.

Receptor Group	Scientific Name	Common Name
Mammalian Fauna		
Herbivorous Mammal	*Microtus pennsylvanicus*	Meadow Vole
Insectivorous Mammal	*Blarina brevicauda*	Northern Short-tailed Shrew
Carnivorous Mammal	*Mustela frenata*	Long-tailed Weasel
Avian Fauna		
Herbivorous Bird	*Zenaida macroura*	Mourning Dove
Invertivorous Bird	*Scolopax minor*	Woodcock
Carnivorous Bird	*Buteo jamaicensis*	Red-tailed Hawk

Representative aquatic/semi-aquatic species for each receptor group based on feeding guild are provided below.

Receptor Group	Scientific Name	Common Name
Mammalian Fauna		
Piscivorous Mammal	*Mustela vison*	Mink
Avian Fauna		
Invertivorous Bird	*Cinclus mexicanus*	American Dipper
Piscivorous Bird	*Megaceryle alcyon*	Belted Kingfisher

The focus of evaluation for each exposure area is dependent upon the habitat present and the receptors that are likely to utilize that habitat. **Table 3-1** presents a qualitative assessment of potential use of exposure areas based on the specific habitat requirements of identified receptors of concern. For terrestrial exposure areas, the risk characterization focused on organisms that have a majority of their exposure associated with terrestrial exposure pathways (i.e., all receptors except the mink, American dipper, and belted kingfisher). Similarly, the focus of aquatic exposure areas was those receptors who primarily ingest prey living in the water column or benthos. Transitional exposure areas evaluate all receptors, as both terrestrial and aquatic species may utilize the habitat during periods of inundation and dry conditions. Plant, invertebrate, and herptile communities were also evaluated, where appropriate, based on the availability of published toxicity data for organisms that occupy similar niches.

The United States Fish and Wildlife Service Information for Planning and Consultation (USFWS IPaC; https://ecos.fws.gov/ipac) indicated that six federally threatened (or proposed threatened) species may occur at the Site. No federally endangered species were identified by the USFWS IPaC search. The six federally threatened (or proposed threatened) species identified by USFWS IPaC are presented in the following table, along with general habitat requirements.

Scientific Name	Common Name	Status	Potential Exposure Area – General Habitat Requirements
Mammals			
Lynx canadensis	Canada Lynx	Threatened	Terrestrial – Moist, boreal spruce-fir forest habitat, particularly dense stands of young conifers.
Ursus arctos horribilis	Grizzly Bear	Threatened	Terrestrial – Relatively undisturbed mountainous habitat ranging from dense forest to subalpine meadows.
Gulo gulo luscus	North American Wolverine	Proposed Threatened	Terrestrial – High elevation habitat near the tree-line, typically in remote areas.
Birds			
Coccyzus americanus	Yellow-billed Cuckoo	Threatened	Terrestrial – Dense, wooded habitats with cover and water nearby, particularly cottonwood-dominated forests canopies.
Fish			
Salvelinus confluentus	Bull trout	Threatened	Aquatic – Cold-water, clean lake and stream habitats, with complex habitat features (e.g., riffles, pools, undercut, banks, structure).
Plants			
Silene spaldingii	Spalding's Catchfly	Threatened	Terrestrial – Bunchgrass grasslands and sagebrush-steppe, and occasionally in open-canopy pine stands.

The USFWS IPaC also indicated that critical habitats for the federally threatened bull trout and eight migratory USFWS Birds of Conservation Concern may occur at the Site. The migratory Birds of Conservation Concern are presented in the following table.

Scientific Name	Common Name	Breeding Season
Carpodacus cassinii	Cassin's Finch	May 15 – July 15
Aechmophorus clarkii	Clark's Grebe	All year
Tringa flavipes	Lesser Yellowlegs	Breeds Elsewhere
Numenius Americanus	Long-billed Curlew	April 1 – July 31
Limosa fedoa	Marbled Godwit	May 1 – July 31
Contopus cooperi	Olive-sided Flycatcher	May 20 – August 31
Selaphorus rufus	Rufous Hummingbird	April 15 – July 15
Tringa semipalmata	Willet	April 20 – August 5

3.3.7 Ecotoxicity of Primary Constituents of Potential Concern

The results of the Phase I and Phase II Site Characterization (Roux, 2017a and 2019) and SLERA (Roux, 2017b) indicated that cyanide, fluoride, and PAHs are the primary COPCs identified within the potential source areas and site features. Metals were also frequently detected in site media at maximum concentrations exceeding conservative ESVs in the SLERA. The following sections present a review of the ecotoxicity of these constituent groups in aquatic, transitional, and terrestrial exposure areas identified at the Site.

3.3.7.1 Cyanide

Cyanide is a general term that is used to refer to several compounds that contain a carbon-nitrogen functional group where the two atoms are bound together with a triple bond. Cyanide occurs in multiple forms in the environment. In water, cyanide can occur in strong and weak metal-cyanide complexes, as cyanate or thiocyanate, organocyanides, or as free cyanide. In solid phases, cyanides can occur in simple metal cyanide solids, complexes with alkali earth metals, or in complexes with other metals (Jaszczak et al., 2017). The toxicity of cyanide depends on its form. Free cyanide, including the liberated anion of cyanide (^{-}CN) as well as hydrogen cyanide (HCN), and soluble cyanide salts are the most acutely toxic forms of cyanide.

During the aluminum reduction process many chemical reactions can take place within the smelting potliner, which consists of the refractory lining, carbon cathode, and carbon sidewalls. Some of the chemical reactions that take place within pot lining materials are responsible for the production of cyanide compounds. Cyanide, along with other potentially hazardous compounds such as fluorides, can accumulate within the potliner during its operational lifespan. Once the liner has reached its operational lifespan and is removed from the pot lines, it is considered spent potliner (SPL), which is regulated as hazardous waste by the USEPA (Silveira et al., 2002). The presence of sodium-cyanide (NaCN) in SPL is of greatest concern because it is a soluble cyanide salt. Other less-soluble cyanide compounds, such as sodium ferrocyanide, are also present in large quantities within SPL (Courbariaux et al., 2004). Lisbona et al. (2012) determined the soluble cyanide fraction of SPL using a water washing approach; approximately 20 percent of the total cyanide within the studied SPL was soluble.

The primary mode of toxicity of cyanide compounds is disruption of cellular respiration. More specifically, cyanide causes histotoxic hypoxia, or the inability for cells to take up oxygen. The mechanism that causes disruption to cellular respiration is free cyanide binding with the trivalent iron within cytochrome oxidase, an essential enzyme in the electron transport chain. Once bound, the synthesis of adenosine triphosphate (ATP) ceases and cellular function ceases due to the lack of energy (Jaszczak et al., 2017). Cyanide ions can also affect other enzymatic paths in flora and fauna (Ebbs, 2004), and react with hemoglobin (Lanno and Menzie, 2006). The ecotoxicity of cyanide is discussed for aquatic and terrestrial receptors below.

Aqueous forms of cyanide in the aquatic environment are broadly categorized into four classes: free cyanide, metal-cyanide complexes, cyanate/thiocyanate species, and organocyanide compounds (Ghosh et al., 2006). Metal-cyanide complexes may be further divided into weak metal-cyanide complexes and strong metal cyanide complexes. The dissociation of metal-cyanide complexes is dependent on pH, temperature, and reduction-oxidation potential. Weak acid dissociable (WAD) complexes with certain transition metals (Cu, Ag, Zn, Cd, Ni, and Hg) dissociate under weak acid pH (approimately 4.5); metal-cyanide complexes with other transition metals (Au, Fe, Pt, Pd, and Co) are highly resistant to dissociation and only dissociate under strong acid conditions (pH approximately 1-2) and high temperatures (100 ^{o}C). Several metal-cyanide complexes are known to be photochemically reactive. In the presence of ultraviolet (UV) light, the photolysis of ferrocyanide and ferricyanide complexes results in the formation of free cyanide, as HCN. The rate of photochemical dissociation is dependent on pH, free cyanide concentration in solution, UV intensity, temperature, turbidity, water column depth (Ghosh et al., 2006). Toxic free cyanide (HCN + $^{-}$CN) formed through photodegradation or other mechanisms does not tend to persist in aquatic environments because rapid biodegradation or volatilization occurs within the water column. Free cyanide can be oxidized to form cyanate ($^{-}$CNO) or react with sulfur to form thiocyanate ($^{-}$SCN), which are relatively nontoxic in comparison with free cyanide (Ghosh et al., 2006).

Cyanide exposure in aquatic environments occurs through direct contact with and ingestion of cyanide-containing water. This exposure occurs through ingestion or rapid gill uptake by aquatic organisms. Semi-aquatic organisms can also be exposed through drinking cyanide-containing water. Exposure to less soluble forms of cyanide in water (WAD complexes) may be problematic to mammalian and avian receptors, because cyanide can be liberated in the stomach due to the acidic and anoxic conditions. Incidental ingestion of cyanides in sediment is not a significant exposure pathway because free cyanide and weak metal–cyanide complexes tend to not accumulate in sediments unless organic carbon is abundant (Higgins and Dzombak, 2006). The reactive nature of free cyanide in water and its acute toxicity to (and rapid metabolism within) organisms limits the potential for bioaccumulation (Eisler, 1991; Lanno and Menzie, 2006). Species mean acute toxicity values for 28 freshwater species ranged from 0.046 to 10 milligrams of cyanide per liter (mg CN/L) (Lanno and Menzie, 2006). Chronic data are much more sparsely available for cyanide, and chronic toxicity values ranged between 0.008 and 0.079 mg CN/L for five freshwater and two marine species (Lanno and Menzie, 2006).

In terrestrial environments, free cyanide is typically not present. Upon entering the soil matrix via groundwater or deposition, free cyanide is rapidly complexed with metals to form cyanide-metal complexes, metabolized through microbial processes, or volatilized (Lanno and Menzie, 2006). Because cyanide compounds do not typically bioaccumulate, direct contact exposure and incidental ingestion of soils containing cyanides are the primary exposure routes for cyanides in terrestrial organisms. The mode of toxicity of cyanide to terrestrial plants is similar to that of fauna. Enzymatic binding to cytochrome oxidase results in cessation of cellular electron transport (Yu, 2015). Some plant species can assimilate or metabolize cyanide, and phytoremediation techniques as a means to cleanup terrestrial cyanide have been extensively studied (Yu, 2015).

The literature regarding cyanide bioavailability and toxicity summarized in this section was used to support the development of ecological benchmark concentrations for relevant exposure media in an interim deliverable (**Appendix A1**), as well as the Effects Analysis of this BERA.

3.3.7.2 Fluoride

Fluoride is naturally abundant in soils and contained in the minerals apatite ($Ca_5(PO_4)_3F$), fluorite (CaF_2), cryolite (Na_3AlF_6) and micaceous clay materials. Potassium fluoride (KF) and sodium fluoride (NaF) are soluble salts that contain fluoride. The fluoride-containing feedstocks used in smelting include fluorite, aluminum fluoride (AlF_3), and cryolite. Synthetic cryolite is the predominate flux compound used in aluminum smelting. Fluorite has the lowest solubility in water (16 milligrams per liter [mg/L] at 20 degrees Celsius) and cryolite is also relatively insoluble in water (420 mg/L at 20 degrees Celsius). Aluminum fluoride has an increased solubility in water of 6,700 mg/L at 20 degrees Celsius. KF and NaF represent the most soluble sources of fluoride with solubility in water at 20 degrees Celsius of 95,000 mg/L and 40,400 mg/L, respectively. NaF and KF are often used in toxicity testing of fluoride for both aqueous and solid matrices. The ecotoxicity of fluoride is discussed for aquatic and terrestrial receptors below.

Aquatic invertebrates and fish tend to take up fluoride directly from water, and, to a lesser extent, from consumption of organisms that contain fluorides. Fluorides can bioaccumulate within aquatic organisms, typically in exoskeletons for invertebrates and skeletal bones in fish. In aquatic flora, fluoride can accumulate in plant and root tissues.

The toxic action of fluoride is linked to the strong electronegative state of fluoride ions, which act as enzymatic poisons. Key enzymes, for which their activity can be compromised by the presence of fluoride ions include: phosphatase, hexokinases, enolase, succinic, dehydrogenase, pyruvic oxidase, and others (Camargo, 2003). The decreased enzymatic activity results in interruption of key metabolic processes, such as glycolysis and protein synthesis (Kessabi, 1984). The specific mechanism that causes the decoupling of metabolic processes due to enzymatic activity inhibition is not fully understood.

Increased fluoride concentration, exposure time, and water temperature increases the toxic effects of fluoride to aquatic invertebrates (Camargo, 2003). Inorganic fluorides in solution can be removed from the aquatic phase by precipitation in the presence of calcium carbonate, calcium phosphate, calcium fluoride and, magnesium fluoride (Stumm and Morgan, 1996). Therefore, harder or more saline water tends to be less toxic to aquatic invertebrates. An evaluation of available literature for freshwater acute and chronic effect endpoint data indicated that *Hyalella azteca,* an amphipod, exhibits the greatest sensitivity to fluoride among the freshwater invertebrate species used for toxicological testing. The 10 and 50 percent inhibition concentrations (IC_{10} and IC_{50}) based on growth inhibition were 1,800 and 4,100 micrograms of fluoride per liter (µg F/L), respectively at a hardness of 90 mg/L $CaCO_3$ and chloride content of 2,000 micrograms of chloride per liter (µg Cl/L) (Pearcy et al., 2015).

Increased fluoride concentration, exposure time, and water temperature also increases the toxic effects of fluoride to fish (Camargo, 2003). However, increasing intraspecific fish size and increasing calcium and chloride concentrations in water tends to decrease the toxic effects of fluoride to fish. Based on recent work by Pearcy et al. (2015), it appears that chloride concentration in surface water has a greater influence on the reduced toxicity of fluoride to freshwater organisms than calcium carbonate. Chloride concentration in water does reduce the toxic effects of fluoride to certain species; however, chloride does not mitigate toxic effects for all species. An evaluation of available literature for freshwater acute and chronic effect endpoint data indicated that *Oncorhynchus mykiss*, the rainbow trout, exhibits the greatest sensitivity to fluoride among the freshwater fish species used for toxicological testing. The IC_{10} and IC_{50} were 6,000 and greater than 64,100 µg F/L, respectively, at a hardness of 6 mg/L $CaCO_3$ and chloride content of 2,000 µg Cl/L (Pearcy et al., 2015).

Depending upon concentration, exposure time, and species, fluoride can have inhibitory or enhancing effect on freshwater algal growth (Camargo, 2003). Like terrestrial plants, fluoride content in aquatic macrophyte tissue increases with increasing water concentration and exposure time. An evaluation of available literature for freshwater acute and chronic effect endpoint data for aquatic plants indicated that *Chlorella vulgaris,* a green algae, exhibits a sensitivity to fluoride. The non-inhibitory concentration and lethal concentration in 50 percent of the test organisms (LC_{50}) were 66,500 and 380,000 µg F/L, respectively at a pH of 6.8 (Rai et al., 1998).

In terrestrial environments, fluoride can have effects on plant roots and aboveground vegetation depending on uptake mechanisms, as well as the age and source of fluoride. Plants can take up fluorides from soil and transfer them to foliar tissues through xylematic flows (Fornasiero, 2001). When taken up by roots, some residual fluoride is accumulated into root tissue; however, much of the fluoride is transported to shoot or leaf biomass (Jha et al., 2009).

In addition to potential uptake from soil, gaseous fluorides can be absorbed through leaf stomata and be transferred to foliar tissues through xylematic flows (Zouari et al., 2014). When exposure is predominately atmospheric, accumulation of fluoride in plant roots is much less than when exposure is predominately through soil sources (Baunthiyal et al., 2014). However, the uptake of fluoride into foliar tissue has been shown to decrease, coincident with decreasing atmospheric fluoride concentrations. For example, Horntvedt (1995) found no apparent long-term effects in spruce and pine needles from fluoride accumulation into foliar tissues over a period of approximately 25 years with coincidental decreases in atmospheric fluoride emissions. This suggests that both the age and source of fluoride contamination may affect its uptake and toxicity within the terrestrial environment.

The most common visible symptom of fluoride toxicity in terrestrial plants is foliar damage (leaf necrosis). This occurs due to several morphological modifications to the upper and lower epidermis. Collapse of mesophyll results in cell distortion and sharpening (Fornasiero, 2001). Leaf necrosis can occur along the leaf margin (sides) or at the tip of the leaf (apical leaf necrosis).

High internal fluoride concentrations affect multiple physiological and metabolic plant processes (Yadu et al., 2016). Elevated fluoride can reduce growth and development, affect rates of photosynthesis, and disrupt multiple enzymatic processes. However, the effects of fluoride on growth and development of terrestrial plants vary considerably between species (Baunthiyal et al., 2014). Coniferous trees have been identified as sensitive plant species for exposure to fluoride. Zwiazek and Shay (1988) reported a lowest observed effect concentration (LOEC) for *Pinus banksiana* (jack pine) seedlings for growth of 3 mg F per kilogram (kg) dry weight (dw) of sand. Effects were observed after 29 hours. Arnesen (1997) reported a LOEC for *Lolium muliflorium* (ryegrass) growth of 400 mg F/kg dw.

The effect of fluoride on terrestrial invertebrates is not as well studied as the effects on plants and higher trophic levels. Increased fluoride concentration and exposure time has been shown to increase fluoride body burden to the terrestrial invertebrate *Eisenia fetida* (Lawson and Yu, 2003). The accumulation of fluoride by numerous other invertebrates from fluoride contaminated soils has also been studied (Buse, 1986).

The fluorination of soils by the addition of super phosphate fertilizers (e.g., monocalcium phosphate, $Ca(H_2PO_4)_2$) has resulted in many studies which focus on the effects of fluorides on grazing animals such as sheep and cows. Ingestion is the primary exposure route for fluoride in higher trophic level organisms. Fluoride compounds are absorbed in the stomach and small intestine, where acidic conditions can convert recalcitrant forms of fluoride into more bioavailable forms (Cronin et al., 2000). Threshold soil fluoride concentrations for cattle and sheep were between 326 and 1,085 mg F/kg soil dw and 372 and 1,461 mg F/kg soil dw, respectively. More recent evaluation of terrestrial exposure by Pascoe et al. (2014) found that the lowest no observed adverse effects level (NOAEL) and lowest observed adverse effects level (LOAEL) risk-based concentrations were 149 mg F/kg soil dw and 659 mg F/kg soil dw, respectively.

One key consideration to the ecotoxicity of fluoride in soils is the degree to which fluoride is adsorbed to soil particles. Fluoride adsorption is greatest in acidic non-calcareous soils containing aluminum hydroxides, where fluorides occur predominantly as aluminum fluorosilicate complexes (Pascoe et al. 2014). In slightly alkaline soils with sufficient calcium carbonate ($CaCO_3$), soluble fluoride would be most likely completely fixed as CaF_2 (Brewer, 1966) and less bioavailable. However, an increasing electrostatic potential at even higher pH decreases the retention of fluoride on the soil and increases solubility. This is partially attributed to the displacement of adsorbed fluorine by the increased concentration of hydroxide ions (Larsen & Widdowson, 1971).

The literature regarding fluoride bioavailability and toxicity summarized in this section was used to support the development of ecological benchmark concentrations for relevant exposure media in an interim deliverable to the BERA Work Plan (**Appendix A1**), as well as the Effects Analysis of the BERA Report. The derivation of ecological benchmark concentrations considers the site-specific conditions in terrestrial, transitional, and aquatic exposure areas that may influence fluoride bioavailability and toxicity to representative ecological receptors.

3.3.7.3 Polycyclic Aromatic Hydrocarbons

PAHs are a group of organic compounds that contain at least two condensed aromatic ring structures. When a PAH has three or less condensed aromatic rings, it is considered a low molecular weight PAH (LMW PAH). When it has four or more aromatic rings, it is considered a high molecular weight PAH (HMW PAH; USEPA, 2007a). During the production of aluminum using the Hall-Héroult process, carbon anodes and cathodes are used to conduct electricity through the alumina to produce molten aluminum. The coal tar pitch and coke used to create carbon anodes and cathodes contain multiple PAH compounds. The ecotoxicity of PAHs in aquatic and terrestrial environments are discussed below.

In aquatic environments, it is generally accepted that PAH compounds exert toxicity to benthic invertebrates primarily by a narcosis mode of action (USEPA, 2003a; DiToro et al., 2000; Swartz et al., 1995; Russom et al., 1997; McGrath et al., 2004). Narcosis is a nonspecific, reversible disruption of neural activity (i.e., anesthesia). Based on the similar mode of action of PAH compounds, the toxicity of multiple PAH compounds in a sediment mixture is approximately additive; therefore, exposure to the PAH mixture must be evaluated to assess potential toxicity in sediment (USEPA, 2003a). The composition of individual compounds within PAH mixtures and the relative contribution of those compounds to the additive toxicity to the benthic community vary depending on the source of PAHs.

Additional modes of ecotoxicity include phototoxicity, whereby exposure to UV light increases the toxicity of PAHs. Phototoxicity has been demonstrated in aquatic environments (van Brummelen et al., 1998; Weinstein and Polk, 2001). However, comparisons by Swartz et al. (1995) suggest that responses of benthic communities in PAH-contaminated sites correlate well with the toxicity that is predicted based on narcosis, suggesting that phototoxicity was not a major confounding factor for those environments.

Similar to aquatic receptors, the primary mode of toxicity of PAHs to terrestrial invertebrates is through narcosis (Sverdrup et al., 2002). Soluble phases of PAH compounds found in interstitial pore waters present the greatest risk to invertebrates through ingestion or incidental ingestion. For LMW PAHs, 10 percent effect concentrations (EC_{10}) for reproduction or growth for several invertebrate species ranged from 8 to 113 milligrams per kilogram (mg/kg) dw, whereas the EC_{10} or the maximum acceptable toxicant concentration (MATC) for soil invertebrates exposed to HMW PAHs ranged from 10 to 80 mg/kg dw (USEPA, 2007a). Higher molecular weight PAH compounds generally exhibit greater toxicity to organisms, particularly mammals due to the carcinogenic and mutagenic properties. Mammalian insectivores, the most sensitive receptor group, can have a variety of physiological responses to PAH exposure (USEPA, 2007a).

The literature regarding PAH bioavailability and toxicity summarized in this section was used to support the development of ecological benchmark concentrations for relevant exposure media in an interim deliverable (**Appendix A**), as well as the Effects Analysis of the BERA Report. The derivation of ecological benchmark concentrations will consider the site-specific conditions in terrestrial, transitional, and aquatic exposure areas that may influence PAH bioavailability and toxicity to representative ecological receptors.

3.3.7.4 Metals

The availability of metals to be incorporated into biological tissues does not necessarily correspond with the total concentration of metals in soil, sediment, or surface water; bioavailability is directly related to the speciation of metals. For most divalent metals, the most bioavailable and toxic forms of metals are the metal ions or small metal-anion complexes, which are present at very low concentrations in the environment.

In sediments, most metals are not available for uptake due to strong complexation by solid phases. For example, metals precipitated as metal-sulfide ligands may be resistant to solubilization under typical geochemical conditions observed in sediment or sediment pore water (Sigg and Behra, 2005). The soluble phase of metal ions in sediment pore water is generally the most bioavailable and potentially toxic form to ecological receptors. Equilibrium partitioning theory may be used to predict the bioavailability toxicity of metals in sediment based on the partitioning of simultaneously extracted metals (SEM) between acid volatile sulfides (AVS), total organic carbon (TOC), and pore water (USEPA, 2005a). In reduced sediments, free metal ions partition to AVS and TOC to form insoluble metal sulfide complexes that have low bioavailability and are associated with low toxicity to benthic organisms in toxicity tests (USEPA, 2005a). Metals concentrations directly measured in filtered pore water samples represent the dissolved fraction of metals, which is bioavailable and can be incorporated into the tissues of benthic invertebrates (USEPA, 2005a).

Many metal compounds are essential to maintaining cellular homeostasis. However, when metal concentrations exceed what is needed to maintain normal organismal functions, toxic effects can occur (Valko et al, 2005). Metal-induced toxicity can occur by several mechanisms in organisms, including hepatotoxicity (liver toxicity), neurotoxicity (brain toxicity), and nephrotoxicity (kidney toxicity). Iron, copper, chromium, vanadium, and cobalt can undergo redox-cycling reactions that can lead to deleterious types of oxidative stress. Mercury, cadmium, and nickel can deplete glutathione, which is an essential antioxidant in organisms. Arsenic primarily acts on organisms by binding to thiols, which can disrupt important enzymatic functions (Valko et al, 2005). The ability of metals to bioaccumulate within organisms varies depending on the receptor group and type of metal. Some metals biomagnify (e.g., mercury), or increase in concentration within receptor tissues moving up to higher trophic level.

The literature regarding the bioavailability and toxicity of metals summarized in this section was used to support the development of ecological benchmark concentrations for relevant exposure media in an interim deliverable (**Appendix A**), as well as the Effects Analysis of the BERA Report. The derivation of ecological benchmark concentrations will consider the site-specific conditions in terrestrial, transitional, and aquatic exposure areas that may influence metal bioavailability and toxicity to representative ecological receptors.

3.4 SLERA Refinement of Constituents of Potential Ecological Concern

A refinement of COPECs identified in the SLERA was conducted based on the Phase I Site Characterization data (Roux, 2017b) to identify and provide context for those constituents that are likely to be focal COPECs in the BERA process. Refinement steps included consideration of additional factors that support the removal of some screening-level COPECs from further consideration because they are highly unlikely to adversely impact ecological receptors. The results of this refinement of COPECs identified in the SLERA based on Phase I sampling results was presented in the BERA Work Plan (EHS Support, 2018). The results of that refinement were used to inform decisions regarding the collection and analysis of Phase II data. However, because this BERA investigation includes a re-analysis of all of the ecological risk assessment steps based on the combination of Phase I and Phase II Site Characterization data, the results of the SLERA COPEC refinement are not presented in this document. Screening-level and refined selections of BERA COPECs based on the combined Phase I and Phase II Site Characterization datasets are presented in **Section 4.3** through **Section 4.5**.

3.5 Data Quality Objectives

Following the initial SLERA, the Phase II Site Characterization SAP (Roux, 2018a) presented the detailed study design and supporting data quality objective (DQO) process to evaluate site-specific ecological risk based on identified assessment endpoints, risk questions, and measurement endpoints defined in the baseline problem formulation. The development of the study design in the Phase II Site Characterization SAP was guided by the USEPA DQO process, which is a seven-step planning approach to develop sampling designs for data collection activities that support decision making (USEPA, 2000a). Per USEPA (1997), the goals of the DQO process in the context of ERAGS are to:

- Clarify the study objective and the most appropriate types of data to collect.
- Determine the most appropriate field conditions under which to collect the data.
- Specify acceptable criteria that will be used as the basis for establishing the quantity and quality of data needed to support risk management decisions.

As part of the Phase II Site Characterization SAP, a DQO-based sample size evaluation was conducted to approximate the minimum sample sizes needed to estimate unknown population parameters (e.g., mean, upper confidence limits of the mean [UCL_{mean}]) of COPECs and COPCs in soil to support the BERA and Human Health Risk Assessment (HHRA), respectively (Roux, 2018a).

3.6 BERA Conceptual Study Design

The conceptual study design for the BERA was presented in the BERA Work Plan (EHS Support, 2018) and incorporated into the Phase II Site Characterization SAP (Roux, 2018a). The design identified key data objectives for the Phase II Site Characterization to support the evaluation of assessment endpoints and risk questions based on defined measurement endpoints identified in the BERA problem formulation for aquatic, transitional, and terrestrial exposure areas at the Site.

The BERA Work Plan (EHS Support, 2018) presented an analysis of data gaps identified in the SLERA and developed a conceptual plan for collecting additional data during the Phase II Site Characterization to support the BERA process. This conceptual plan outlined the strategy to collect additional data during the Phase II Site Characterization that would provide the spatial adequacy, vertical characterization of soil in ecological depths of exposure, sufficient sample size, and information related to COPEC bioavailability in a particular medium necessary for developing sound conclusions about the potential for ecological risk at the site. These objectives were obtained by:

- Collecting soil samples within the 0 to 0.5 and 0.5 to 2 feet below ground surface (ft-bgs) intervals at all exposure areas (the BERA Work Plan [EHS Support, 2018] provided justification for this soil depth as the relevant soil interval for ecological risk based on receptor exposure patterns and an evaluation of Phase I data that indicated generally decreasing concentrations with increasing soil depths for most constituents at most locations). A similar evaluation was performed after the Phase II samples were collected and analyzed. As described in the DSR, samples collected at depth intervals deeper than 2 ft-bgs for key site contaminants had average concentrations that were an order of magnitude or lower than concentrations detected within the 0 to 2 ft-bgs interval (see Section 4.2.1.11 in Roux, 2019). Thus, the assumption that exposure point concentrations based on data from the 0 to 2 ft-bgs interval provides a conservative estimate of exposure to ecological receptors was confirmed by the analysis of Phase I and Phase II Site Characterization datasets.
- Ensuring that enough samples (generally 8 to 10 samples, at a minimum) were collected in each exposure medium in each exposure area to calculate 95 percent UCL_{mean} based on the DQO-based minimum sample size evaluation.
- Collecting data to evaluate the bioavailability of constituents to ecological receptors, such as collecting both filtered and unfiltered surface water data, analyzing soil samples for parameters (e.g., pH, organic carbon) that affect the potential for binding constituents in the medium matrix in non-bioavailable forms, and analyzing sediment pore water and acid volatile sulfides-simultaneously extracted metals (AVS-SEM) in sediment.

3.6.1 Aquatic Exposure Areas

Surface water analyses in aquatic exposure areas included analyses of filtered (dissolved) and unfiltered samples for metals, cyanide, free cyanide, and fluoride. Consistent with the analyses of pore water in sediment, the freely dissolved fraction is a better indicator of potential bioavailability and toxicity of COPECs in surface water. Surface water analyses included the analysis of free cyanide, which is more representative of the bioavailable and toxic form of cyanide. Free cyanide analysis of surface water provides a ‘snapshot’ of the bioavailable and toxic form of cyanide in the water at any one time. Under different environmental conditions (e.g., ultraviolet light exposure, temperature, pH), different concentrations of free cyanide may be present depending on the cyanide liberated from metal cyanide complexes and the amount of hydrogen cyanide volatilized off. The sampling programs implemented as part of the Phase I and Phase II Site Characterization in areas where elevated cyanide have been detected were designed to provide comprehensive datasets to characterize the spatial and temporal variability in free and total cyanide concentrations in surface water under varying environmental conditions.

The BERA Work Plan provided for the evaluation of the bioavailability and toxicity of COPECs in sediment within aquatic exposure areas using a tiered approach that is consistent with framework presented in USEPA guidance for evaluating ecological risk to benthic receptors from PAHs in sediment (USEPA, 2009). The tiered approach is applicable to the evaluation of PAHs and other organic and inorganic COPECs in sediment. The tiered approach includes the following components:

- Tier 1 – Assessment of COPEC bioavailability based on whole sediment analysis
- Tier 2 – Assessment of COPEC bioavailability based on pore water analysis
- Tier 3 – Assessment of COPEC bioavailability using the Sediment Quality Triad (SQT) approach and/or tissue analyses

Data to support Tier 1 and Tier 2 assessments were collected as part of the Phase I and Phase II Site Characterizations. The need for and scope of potential Tier 3 analyses may be further evaluated pending the outcome of the BERA.

Tier 1 analyses of COPEC bioavailability, including predictive models based on equilibrium partitioning (EqP) relationships, were completed for select constituent groups based on Phase I Site Characterization Data in the SLERA and COPEC Refinement (**Section 3.4**). Tier 1 analyses were also conducted in this BERA on additional data collected during the Phase II sampling as part of a weight-of-evidence evaluation for exposure. Predictive EqP models estimate the bioavailable fraction of COPECs in pore water based on the partitioning of COPECs between sediment organic carbon, pore water, and biota. EqP equilibrium partitioning sediment benchmarks (ESBs) represent concentrations of organic constituents in bulk sediment that, at equilibrium, would result in partitioning to sediment pore water at concentrations equivalent to a water quality benchmark (WQB) that may be based on no observed effect concentration (NOEC) or LOEC endpoints for survival, growth, or reproduction. Further refinement of these predictive approaches may be conducted as part of Tier 1 analyses consistent with the following USEPA guidance:

- PAHs: *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures* (USEPA, 2003a)
- Divalent metals: *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metals Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc)* (USEPA, 2005a)
- Nonionic Organic Compounds: *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Compendium of Tier 2 Values for Nonionic Organics* (USEPA, 2008a)

For organic COPECs lacking ESB values from the above sources, site-specific ESBs may be derived using the sample-specific fraction of organic carbon (f_{oc}), constituent-specific organic carbon-water partitioning coefficient (K_{oc}), and WQB based on the following EqP relationship:

$$ESB = (f_{oc} \times K_{oc} \times WQB)$$

where:

ESB = EqP Sediment Benchmark (µg/kg dw sediment)

f_{oc} = Sample-specific fraction of organic carbon in sediment
K_{oc} = Organic carbon-water partitioning coefficient (L/kg)
WQB = Water quality benchmark (µg/L)

The use of conservative partitioning coefficients and WQB values in predictive EqP models minimizes the potential for false negatives (i.e., erroneously eliminating a constituent from further consideration) in the Tier 1 analyses.

Tier 2 analyses were conducted as part of the Phase II Site Characterization in aquatic exposure areas where Tier 1 analyses indicate the potential for adverse ecological effects based on predictive models. Tier 2 analyses consist of the direct measurement of the freely dissolved COPEC fraction in sediment pore water and direct measurements of bioavailable fractions in bulk sediment. The freely dissolved fraction better predicts COPEC bioavailability and toxicity in sediment when compared to bulk sediment analyses. Direct measurements of COPEC concentrations in pore water provide an empirical measurement to supplement the conservative theoretical estimate of COPEC concentrations in pore water derived from predictive EqP models.

In addition to pore water analyses, analyses of bioavailable fractions in sediment are considered in Tier 2 analyses. Measurements of AVS-SEM were collected during the Phase II investigation in inundated or saturated sediments where divalent metals may be elevated above sediment ESVs based on total recoverable analyses (USEPA, 2005a). Soluble fluoride was also analyzed in sediment to evaluate the potential bioavailability and toxicity of fluoride to benthic organisms.

3.6.2 Terrestrial Exposure Areas

The bioavailability of metals, cyanide, fluoride, and PAHs in soils is complex and influenced strongly by pH, cation exchange capacity (CEC), organic matter content, localized hydrology, and grain size. Soil pH is considered the primary soil variable, because it controls many soil biogeochemical processes and has a significant influence on constituent bioavailability (USEPA, 2007b). Depending on COPEC speciation, and whether it is complexed or sorbed to organic matter or clay, some portion of soil COPECs may not be bioavailable because they do not readily dissolve in water or solubilize during passage through organism intestines.

The BERA Work Plan provided for the conceptual evaluation of the bioavailability and toxicity of COPECs in soils within terrestrial exposure areas based on a tiered approach:

- Tier 1 – Assessment of potential COPEC toxicity based on bulk soil analysis
- Tier 2 – Measurement of COPEC bioavailability and toxicity based on fractional analytical methods
- Tier 3 – Measurement of COPEC bioavailability and toxicity based on *in situ* toxicity studies and/or tissue analyses

The terrestrial exposure evaluations presented in the BERA are based on Tier 1 analyses that evaluate potential soil COPEC toxicity using the available Phase I and Phase II Site Characterization Data in the preliminary COPEC screen and COPEC Refinement (**Sections 4.3** through **4.5**). Tier 1 analyses included comparisons of total COPEC concentrations to ESVs and the identification of important soil physicochemical parameters that help inform soil COPEC bioavailability, particularly soil pH and soil organic carbon content. The need for and scope of potential Tier 2 and 3 analyses may be further evaluated pending the outcome of the BERA.

3.6.3 Transitional Exposure Areas

The evaluation of the bioavailability and toxicity of COPECs in transitional exposure areas used the approaches presented in the preceding sections for aquatic and terrestrial exposure areas. The approach for transitional exposure areas was developed based on localized exposure conditions indicating the likelihood of occurrence of aquatic or terrestrial receptors.

3.6.4 Background Characterization

The adequacy of Phase I Site Characterization data collected to represent background conditions was identified as an uncertainty in the SLERA. Additional background data was collected as part of the Phase II Site Characterization to further characterize COPEC concentrations representative of regional conditions (Roux, 2019).

A Background Investigation SAP (Background SAP) (Roux, 2018b) was developed to establish the data objectives, study design, and methodologies that were used to establish a representative background dataset. As described in the Phase II Data Summary Report, (Roux, 2019) soil background locations were distal to industrial operations at CFAC and have no known waste materials present. Background soil samples were collected from similar soil types as soils identified on the Site. Surface water and sediment sampling locations targeted areas hydraulically upgradient of the Site. Background locations for aquatic environments were located upstream of the Site in locations with similar habitats and substrate characteristics to aquatic exposure areas at the Site.

Sample sizes for soil, surface water, and sediment background datasets were sufficient to develop statistically robust measurements of UCL_{mean}, as well as background threshold values (BTVs) using ProUCL software (USEPA, 2015b). Background datasets had a minimum of 8 – 10 observations for each matrix to support statistical calculations. A full description of the background area sampling and data evaluation is presented in the Phase II DSR (Roux, 2019).

4 Identification of Baseline COPECs

Following a review of the Phase II datasets, it was determined that the components and assumptions presented in the baseline risk assessment problem formulation were still valid and accurate. Although screening-level COPECs from the Phase I data were previously identified in the SLERA (Roux, 2017b), the SLERA concluded that additional samples were required to adequately characterize some portions of the site, and additional samples were collected during a second phase of sampling following the SLERA. Because the initial steps of the risk assessment that were presented in the SLERA (Roux, 2017b) and BERA Work Plan (EHS Support, 2018) were performed only on the Phase I Site Characterization data, the screening-level steps in the risk assessment process are repeated and presented in this BERA for the combined Phase I and Phase II dataset. The results of this evaluation are presented in the following sections.

Exposure areas at the Site were previously defined based primarily on the habitat type identified during the May 2016 habitat assessment (**Section 2.2.3**). These exposure areas were refined in the BERA Problem Formulation (**Section 3.3.1**) based on additional data collection and habitat evaluations that were performed following the SLERA. A total of 13 exposure areas were defined in the BERA refinement. **Figure 3-1** shows the location and extent of each exposure area. **Figures 4-1** through **4-14** present the sample locations that comprised the dataset used for each exposure area, including the incremental sampling grid area in the Operational Area of the Site (**Figure 4-8**). The screening-level COPECs in soil, surface water, and sediment that require further evaluation in each exposure area are presented in the following sections.

4.1 Evaluated Datasets

Data from samples collected in soil, surface water, and sediment during the Phase I Site Characterization, Supplemental South Pond Assessment, and Phase II Site Characterization programs were used to perform an initial screening-level identification of COPECs. The datasets for each medium are briefly discussed below. Detailed descriptions of the sampling efforts are provided in the Phase II Site Characterization Data Summary Report (Roux, 2019). The locations where the soil, surface water, and sediment samples used in the BERA were collected for each medium in each exposure area are presented in **Table 4-1** through **Table 4-13**.

4.1.1 Soils

The Phase I Site-wide soil boring and soil sampling was conducted from May 18, 2016 to August 31, 2016. Soil samples were collected utilizing either sonic-rotary methods, direct push techniques with Geoprobe^{TM} technology, or hand auger as detailed in the Phase I Data Summary Report (Roux, 2017a). In addition, soil samples were collected from test pits conducted within the Borrow Pit area.

Three soil samples were typically collected for laboratory analyses from each soil boring within unpaved areas:

- Surface soil sample from the top 6 inches of soil
- Shallow soil sample from the interval of 0.5 to 2 ft bgs
- Intermediate depth soil sample from a depth of 10 to 12 ft bgs

In paved areas the surficial sample was omitted (due to pavement or solid surface covering) and the shallow sample was collected from the 2-foot depth interval immediately beneath the surface covering materials. At one location (CFMW-28a) adjacent to the Northeast Percolation Pond, an opportunistic soil sample was collected from a depth of 4 to 6 ft bgs based upon the observation of stained soil at that location and depth. In addition, soil samples were collected from eight test pits conducted within the Borrow Pit area in the southeast corner of the Site, with two samples collected from each test pit at depths of 0.5 to 2 ft bgs and 2 to 4 ft bgs.

For the purposes of this BERA, only soil samples collected from less than 2 ft bgs were evaluated as soils. Soils from deeper intervals are not encountered as frequently for most terrestrial receptors, particularly those that do not regularly burrow. The bioaccumulation of constituents from soils into dietary items occurs within the biologically active zone in soil where dietary items are exposed, which is generally contained within the top 1-2 ft bgs (USEPA, 2015a). Burrowing mammals may encounter and incidentally ingest soils at depths greater than 2 ft bgs within burrows. However, the analysis of Phase I and Phase II soil datasets indicates that concentrations of key constituents of concern in site soil generally decline with increasing depth (see **Section 3.6** and Roux, 2019). As a result, ecological exposure to COPECs in soils within the 0-2 ft bgs sampling intervals is typically greater than exposure to subsurface soils (greater than 2 ft bgs). Therefore, exposure estimates for direct dietary ingestion and incidental soil ingestion based on COPEC concentrations within the 0-2 ft bgs sampling intervals provide conservative estimates of exposure to mammalian receptors that potentially burrow in site soils. Soils deeper than 10 feet are not within the biologically active zone and therefore are not part of a complete exposure pathway.

Soil samples were analyzed for the following analytical suites relevant to the BERA:

- Target Compound List (TCL) VOCs (excluding surface soil samples) via USEPA Method 8260
- TCL SVOCs (including PAHs) via USEPA Method 8270
- Target Analyte List (TAL) Metals via USEPA Method 6010
- TCL PCBs via USEPA Method 8082
- TCL Pesticides (select surface samples only) via USEPA Method 8081
- Total Cyanide via USEPA Method 9012
- Fluoride via USEPA Method 300

The Supplemental South Pond Assessment soil sampling was conducted from October 31, 2017 through November 8, 2017. A total of 18 soil borings were advanced and 43 soil samples were collected within the South Percolation Pond Area. Samples were collected in accordance with the standard operating procedures (SOPs) provided in the Phase I SAP (Roux, 2015b) and the specifications of the Expedited Risk Assessment SAP (Roux, 2017d). Soil samples were packaged and shipped under chain-of-custody to Test America Laboratories, Inc. and analyzed for the following analytical suites relevant to the BERA:

- TCL VOCs (excluding surface soil samples) via USEPA Method 8260B
- TCL SVOCs (including PAHs) via USEPA Method 8270D
- TAL metals via USEPA Method 6020A / 7471B
- Total cyanide via USEPA Method 9012B
- Free cyanide via USEPA Method 9016
- Fluoride via USEPA Method 9056A

Phase II soil samples were collected from April 28, 2018 to June 28, 2018 and from September 25, 2018 to September 28, 2018. Locations and analyses were based on information obtained from the Phase I sampling. The Phase II soil samples were analyzed for the following analytical suites relevant to the BERA:

- TCL SVOCs (including PAHs) via USEPA Method 8270 Low Level (LL)
- TAL Metals via USEPA Method 6010
- Total Cyanide via USEPA Method 9012
- Fluoride via USEPA Method 9056A
- Dioxin and furan compounds (polychlorinated dibenzo-dioxin [PCDD] / polychlorinated dibenzo-furans [PCDF]) via USEPA Method 8290A (dioxin delineation samples only)
- TCL PCBs via USEPA Method 8082 (only locations located in the vicinity of the Rectifier Yards and delineation samples within the Operational Area)
- TAL total chromium via USEPA Method 6020A, and Cr(VI) via USEPA Method 7196A (chromium speciation samples only)
- TCL VOCs via USEPA Method 8260 (four opportunistic samples only)

Additional strategies and approaches that were used to evaluate and investigate potential contamination in the soil medium are described in the following subsections.

4.1.1.1 Incremental Soil Samples

In addition to discrete soil sampling, incremental soil sampling was conducted within an area known as the Operational Area. The Operational Area comprises approximately 43 acres within the northern portion of the Main Plant Area and southern portion of the Central Landfill Area where aerial photographs indicate historical operations may have been conducted but no known source area exists. An incremental soil sampling program was conducted within the Operational Area to assess whether any potential source areas are present in this area. The work was performed in accordance with the Scope of Work outlined in the Phase I and Phase II SAPs (Roux, 2015b and 2018a) as well as SAP Field Modification #4 (described in the Phase I Data Summary Report [Roux, 2017a]).

The Operational Area soil investigation was conducted during multiple phases in the June 14, 2016 to May 23, 2018 time frame. The Operational Area was divided into 43 grid cells, also referred to as DUs, each approximately 1 acre in size. Sampling was conducted at the frequency of one incremental surface soil sample (0 to 0.5 ft bgs) and one incremental shallow soil sample (0.5 to 2 ft bgs) per DU, for a total of 43 incremental soil samples from each interval within the 43 DUs that comprise the Operational Area. Each incremental sample consisted of a composite of 32 grab samples (or "increments") that were processed, combined, and subsampled to develop the composite ISS result as described in the Phase II SAP (Roux, 2018a). The grid where samples were collected in the Operational Area is shown on **Figure 3-1** and **Figure 4-8**. Each sample was analyzed for the laboratory analyses noted above, with the exception of VOCs. As described in the Phase I Data Summary Report, samples from the first 15 DUs (designated CFISS-001 through CFISS-015) were collected using field processing methods which included the hand removal of coarse-grained material greater than approximately 0.5 inches in diameter, and hand mixing of the soil volumes in the field from the 32 grab samples. As documented in Field Modification #4, field processing by Roux and Hydrometrics was discontinued at the request of USEPA since the field processing method did not include drying and breaking up soil aggregates and/or sieving as specified in the Interstate Technology and Regulatory Council (ITRC) incremental sampling methodology guidance and as would be done in the lab processing of incremental soil samples (ITRC, 2012a). Three of the initial DUs were re-sampled to allow for a comparison of the results from the two methods. After the results were considered, it was determined that the remaining 12 DUs would be re-sampled as part of the Phase II Site Characterization effort.

A single replicate was collected from most of the grid cells in the Operational Area. However, three replicates were collected from both the 0 to 0.5 ft and the 0.5 to 2 ft soil intervals from four DUs (i.e., 10 percent of the DUs; CFISS-001, -004, -011, and -015) during the Phase II investigation. Based on the results of the sampling, an estimate of variability from replicate sampling was established for the remaining DUs. An evaluation of the relative standard deviation (RSD) was performed on triplicate results where all three results were detections. The calculation indicated that most analytes had an RSD of less than 30 percent between parent and replicate samples. SVOCs, specifically PAHs, had the greatest frequency of greater than 30 percent RSD between parent and replicate samples. The parent and replicate samples from the shallow incremental soil sampling (ISS) sample CFISS-004 had the greatest range of variability, with SVOC RSD values between 58 percent and 144 percent. It should be noted that the Phase II SAP (Roux, 2018a) denotes an acceptance criterion of 50 percent relative percent difference (RPD) for parent and field duplicate soil samples. Duplicate soil samples are typically expected to be more variable than results from replicate water samples due to the physical and chemical heterogeneity of the soil matrix.

The results of triplicate ISS results were consolidated into a single concentration using the updated ITRC 95 percent UCL_{mean} calculator (ITRC, 2012b), as described in the wildlife ingestion BERA work plan interim deliverable (**Appendix A2**). An adjustment was made to detected constituents in the 39 DUs where single incremental samples were collected based on the variability observed for that constituent within the DUs where triplicate sampling was performed. The RSDs calculated and presented in the Phase II DSR (Roux, 2019) for DUs with triplicate incremental samples were used to estimate the potential variance associated with single incremental sample results. The arithmetic mean of RSDs for each constituent and sampling interval combination was used as the adjustment factor for the 39 DUs lacking replicate samples. This adjustment factor was used to calculate the potential range for each non-replicated DU in each depth interval as follows:

$$\text{RSD-adjusted EPC} = [\text{single ISS result}] \times (1 \pm (\text{mean percent RSD}/100)).$$

Additional information regarding how the ISS data were managed and evaluated is provided in **Section 5.3.1**.

4.1.1.2 Chromium Speciation

In an effort to reduce uncertainty in the risk assessment results with respect to chromium in soil, CFAC developed a site-specific ratio of hexavalent chromium [Cr(VI)] to trivalent chromium [Cr(III)] by collecting soil samples that were analyzed for both total chromium and Cr(VI) (Roux, 2019). Twenty soil samples within the depth of ecological exposure (0 to 2 ft-bgs) were analyzed for both Cr(VI) and total chromium. Cr(VI) was detected in only 3 of the 20 samples and comprised a maximum of 3.96 percent of the total chromium in the samples where it was detected. To determine the representative ratio of Cr(VI) to Cr(III) in soil at the Site, the Cr(III) concentration for each of the samples analyzed for Cr(VI) was calculated as the difference in concentration between total chromium concentration and the Cr(VI) concentration. For non-detect Cr(VI) concentrations at these locations, one-half of the MDL was used for the calculation. The ratio of Cr(VI) to Cr(III) was then calculated for each sample. Cr(III) and Cr(VI) results from soil sample CFSB-290-SO-0-0.5 were excluded from the dataset because both total chromium and Cr(VI) were not detected at this location. The 95 percent UCL_{mean} of all the ratios was then calculated using ProUCL software (USEPA, 2015b). ProUCL fit the dataset to a lognormal distribution and returned a 95 percent UCL_{mean} ratio of 0.0198 based on the H-statistic method. To be conservative and to follow suggestions from the ProUCL output form, the lognormal distribution result was rejected, and instead, the nonparametric 95 percent UCL_{mean} ratio of 0.0275 was adopted as the representative ratio.

Concentrations of Cr(III) and Cr(VI) were then estimated for the remaining samples for which only total chromium was analyzed, using the above-calculated ratio of Cr(VI) to Cr(III), *r*, the Total Chromium concentration, *Cr(T)*, and the following equations. The raw dataset and calculations are provided in the Phase II DSR (Roux, 2019):

$$[Cr(III)] = \frac{1}{1+r} * Cr(T)$$

$$[Cr(VI)] = r * \ [Cr(III)]$$

Both the measured total chromium results as well as the estimated Cr(III) and Cr(VI) concentrations based on the above ratio are presented in the soil data tables for each exposure area.

4.1.1.3 Dioxin and Furan Compounds

Concentrations of dioxin and furan congeners were treated according to procedures provided by USEPA and the World Health Organization (WHO) (Van den Berg et al, 1998, 2006; USEPA, 2008b, 2010) and validated according to the appropriate National Functional Guidelines (USEPA, 2016). PCDDs and PCDFs consist of a family of approximately 75 and 135 congeners, respectively. For dioxin and furan congener data, results were converted to 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) toxicity equivalent quotient (TEQ) values using toxicity equivalent factors (TEFs) specific to wildlife from the World Health Organization (Van den Berg et al., 1998) and Van den Berg et al. (2006) for avian and mammalian receptor guilds, respectively. Three scenarios were calculated for non-detected congeners to bracket the range of potential concentrations present in soil. The three values assigned to results that were qualified as non-detected were 0, one-half the MDL, and the MDL. The MDL represents the lower limit of concentrations detectable by the analytical method. Therefore, any concentrations above the MDL are typically reported as estimated values and are recorded as J-qualified concentrations by the laboratory, which are considered usable results for risk assessment. Thus, the MDL represents a conservative upper limit for the potential concentration of dioxin in a sample reported as a non-detected result.

In some cases, dioxin and furan congener results that had a reported laboratory value were flagged with a laboratory qualifier “B” (indicating blank contamination) and a validation qualifier of “U” (indicating that the influence of the blank contamination compromised the confidence of determining if the constituent was present in the sample at all). In such cases, the estimated concentration reported by the laboratory was conservatively used as the surrogate value for the non-detected result rather than the MDL. All reported and surrogate values were then multiplied by the appropriate bird or mammal TEF, and the TEF-adjusted concentrations were then summed to develop the sample 2,3,7,8-TCDD TEQ concentration (USEPA, 2005c).

4.1.1.4 Soil Evaluation in Transitional Exposure Areas

As described in the BERA Work Plan (EHS Support, 2018), soil and sediment in the four transitional areas (i.e., the North Percolation Pond Area, South Percolation Pond Area, Cedar Creek Overflow Ditch, and

Northern Surface Water Feature) were combined and evaluated as both soil and sediment in order to be protective of ecological receptors that may utilize the sites during dry and wet conditions, respectively. For the soil evaluation in these areas, the soil samples (0 to 2 ft-bgs) and sediment samples were combined to form the soil dataset used to evaluate terrestrial exposure scenarios.

4.1.1.5 PAHs

As described in **Section 3.3.7**, PAHs in terrestrial and aquatic environments have similar modes of toxicity on ecological receptors. Toxicity associated with exposure to PAHs in terrestrial environments is typically considered to be additive among LMW PAHs and HMW PAHs (USEPA, 2007a). LMW PAHs are composed of fewer than four aromatic rings and HMW PAHs are composed of four or more rings. In this BERA investigation, LMW PAHs consisted of acenaphthene, acenaphthylene, anthracene, fluoranthene, fluorene, naphthalene, phenanthrene, and 2-mehtylnaphthalene. HMW PAHs consisted of benzo(a)anthracene), benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene. Concentrations of LMW and HMW constituents were summed in the COPEC screening steps and compared to LMW- and HMW-specific ESVs.

PAHs in some soil samples (e.g., in the North Percolation Pond Area) were analyzed using two laboratory analytical methods, 8270D and 8270D-SIM (selected ion monitoring [SIM]). The latter method includes an analysis of additional alkylated compounds that are lacking in the 8270D method, and was intended to enable the calculation of equilibrium partitioning sediment benchmark toxic units (ESBTUs) in the COPEC refinement step (**Section 4.4.1**) based on the full list of 34 PAH compounds (it is noted that these soil samples are in a transitional exposure area, and as such, are evaluated as both soil and sediment in the BERA). For these samples that were analyzed by both methods, the 8270D SIM PAH test was more sensitive (i.e., had lower reporting limits) and were used preferentially over the 8270D method for compounds detected using both methods.

4.1.2 Surface Water

Surface water datasets used in the BERA were comprised of the results of analyses of surface water samples collected over multiple events and hydrologic conditions:

- Phase I Sampling Events:
  - High-Water: June 2016 (Select surface water bodies)
  - Low-Water: September 2016 (Phase I, Round 1)
  - Low-Water: December 2016 (Phase I, Round 2)
  - High-Water: March-April 2017 (Phase I, Round 3)
  - High-Water: June 2017 (Phase I, Round 4)
  - Low-Water: October-November 2017 (Supplemental South Percolation Pond field activities)
- Phase II Sampling Events:
  - High-Water: June 2018 (Phase II, Round 1)
  - Low-Water: October 2018 (Phase II, Round 2)

A description of the phased surface water sampling program is presented below with an evaluation of the sampling events that captured the potential variability in exposure conditions due to temporal variability in surface water hydrology.

4.1.2.1 Phased Surface Water Sampling Program

Phase I surface water samples were collected from site surface water features that were observed to contain water during the Phase I Site Characterization Program. From June 6, 2016 to June 7, 2016, 10 surface water samples were collected from selected surface water bodies that were anticipated to dry-out over the summer months. These locations included the three locations in the South Percolation Ponds, the five locations in the Cedar Creek Reservoir Overflow Ditch, and the two locations in the northern area of the Site where surface water was observed (referred to as the Northern Surface Water Feature on **Figure 2-2**). Surface water was not present within the North Percolation Ponds (North-West and North-East ponds); therefore, surface water samples were not collected from these locations.

From August 29, 2016 to September 16, 2016, 12 surface water samples were collected from within the Flathead River and Cedar Creek during low water conditions. These locations were determined to be wet throughout the entire year. Similar to the June sampling event, surface water samples were not collected within the North Percolation Ponds (North-West and North-East ponds) due to an absence of surface water.

An additional Phase I round of low-water surface water sampling was conducted in December 2016. Phase I high-water sampling rounds were conducted in March-April 2017 and June 2017. In October-November 2017, additional surface water samples were collected in the South Percolation Ponds and Flathead Riparian Area Channel as part of supplemental field activities for the South Percolation Pond Area (Roux, 2017a and 2019).

Phase I surface water samples were analyzed for:

- Total recoverable and one round of dissolved TAL metals (including major cations Ca, Mg, Na, K) via USEPA Methods 200.2 / 200.7 / 200.8 / 245.2 / 6010C / 6020A / 7470A
- Total cyanide via USEPA Method 335.4
- General chemistry including fluoride via USEPA method 300, alkalinity via method SM2023B, and hardness via USEPA method 200.7
- Nutrients including chloride and sulfate via USEPA method 300.0, nitrate and nitrite as N via USEPA method 353.2, ammonia nitrogen via USEPA method 350.1 / 350.3, and orthophosphate as P via USEPA method 365.1
- Total dissolved solids (TDS) and total suspended solids (TSS) via methods SM 2540C/D

In addition to the above analyses, biotic ligand model (BLM) parameters data, including temperature and pH, were also collected. Additional BLM parameters, including dissolved organic carbon and sulfide, were not analyzed in this evaluation but were analyzed during the fourth round of Phase I sampling completed in June 2017.

A Phase II high-water sampling event was performed in June 2018, and a low-water sampling event was performed in October 2018 to assess the temporal variability of surface water quality at the Site. Surface water samples were collected as grab samples from within the Site feature to a maximum depth of approximately 2 feet. Surface water samples were analyzed for:

- Total TAL metals via USEPA Methods 6020A / 7470A
- Dissolved TAL metals via USEPA Methods 6020A / 7470A
- Total cyanide via USEPA Method 335.4
- Free cyanide via USEPA Method 9016

- General chemistry including fluoride via USEPA Method 300, alkalinity via USEPA Method 2320B, and total hardness via USEPA Method 2340C
- Nutrients including total chloride and dissolved sulfate via USEPA Method 300.0, nitrate and nitrite as N via USEPA Method 353.2, ammonia nitrogen via USEPA Method 350.1, sulfide via USEPA Method 4500S2F, and orthophosphate as P via USEPA Method 9056A
- Total cyanide via USEPA Method 335.4, dissolved cyanide via USEPA Method 335.4, and free cyanide via USEPA Method 9016 (four opportunity samples in Cedar Creek TCL SVOCs via USEPA Method 8270 LL)
- Alkylated PAHs via USEPA Method 8270D-SIM (select samples in the Backwater Seep Sampling Area, Riparian Area, and Flathead River)

All surface water samples submitted for analysis of dissolved parameters were field filtered using a standard 0.45-micron filter.

4.1.2.2 Temporal Variability in Surface Water Hydrology

Further evaluation of the long-term discharge record for the Flathead River (USGS Gage 12363000) was conducted to determine how the daily flow conditions at the time of each sampling event compared to flow statistics computed with the entire period of daily records (June 1, 1922 to February 4, 2019). This assessment was carried out to identify how discharge conditions in the Flathead River during Phase I and Phase II surface water sampling events compared to annual flow percentiles, which were calculated for the entire population. Daily discharge of the Flathead River from January 2016 to February 2018 is illustrated in **Figure 3-5**. Sampling was conducted predominately during low flow periods representing the 20^{th} – 50^{th} percentiles of flow (Q_{20}-Q_{50}). June sampling events in 2016, 2017, and 2018 reflect periods of high discharge associated with the spring freshet. Discharge during these events was typically greater than the 85^{th} percentile. The combined evaluation of mean monthly statistics for the last 10 years and flow statistics computed from period of record for the Flathead River demonstrate that aqueous phase sampling conducted during Phase I and Phase II investigations comprise a wide range of hydrologic conditions that effectively capture the temporal variability of discharge.

4.1.3 Sediment

Phase I data collection occurred on August 29, 2016 and from September 6 to 9, 2016. Sediment samples were collected from the same locations as surface water samples immediately following the collection of surface water samples at each location. Sediment sampling also included two locations within the North-East and North-West Percolation Ponds where surface water samples were not collected due to the absence of surface water within those features. Sediment samples were collected when river stage levels were low such that the Flathead River would most likely be acting as a gaining stream. Sediment sample locations for transitional and aquatic exposure areas are shown on **Figure 4-9** through **Figure 4-14**.

Gravel and larger sized grains were removed from the sample by passing the grab sediment sample through a size 10 sieve prior to packaging and shipment for laboratory analysis. Sediment samples were analyzed with the same analytical methods as the soils described in **Section 4.1.1** , including grain size analysis and total organic carbon.

Phase II sediment samples were collected during both the high-water event in June 2018 and the low-water sampling event in October 2018. Sediment samples were collected from surface water sample locations previously sampled during Phase I and Supplemental South Pond Assessment, and additional locations added for the Phase II as described in the Phase II SAP (Roux, 2018a). Sediment samples were analyzed for:

- TCL SVOCs via USEPA Method 8270 LL
- TAL metals via USEPA Method 6020A / 7471B
- Total cyanide via USEPA Method 9014
- Fluoride via USEPA Method 9056A

In addition to the above described analyses, select sediment samples located in the Backwater Seep Sampling Area, Riparian Area, South Percolation Ponds, and the Flathead River were also analyzed for the following additional analytes:

- AVS-SEM via USEPA-821-R-100
- Alkylated PAHs via USEPA Method 8270D (CFSDP-005, 026, 027, 028, 029, and 035)

4.1.3.1 PAHs

The potential effects of PAH-induced narcosis on benthic invertebrate communities can include decreased abundance, diversity, and growth (Environment Canada, 1999). The direct contact toxicity of PAHs is additive. Total PAH (tPAH) values were established for sediment samples based on the summed concentrations of the following compounds that comprise the toxic effect level (TEL) screening value that was used in the initial COPEC screening evaluation: acenaphthene, acenaphthylene, anthracene, benzo(k)fluoranthene, benzo(b)fluorene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, and pyrene.

Similar to the soil samples in the North Percolation Pond Area (**Section 4.1.1.5**), PAHs in some sediment samples in the Flathead River Riparian Area and the Flathead River Area were analyzed using two laboratory analytical methods, 8270D and 8270D-SIM, which includes an analysis of additional alkylated compounds that are lacking in the 8270D method. These data were addressed using the same approach described in **Section 4.1.1.5** for soils.

4.1.3.2 Sediment Evaluation in Transitional Exposure Areas

As described in the BERA Work Plan (EHS Support, 2018), soil and sediment in the four transitional areas (i.e., the North Percolation Pond Area, South Percolation Pond Area, Cedar Creek Reservoir Overflow Ditch, and Northern Surface Water Feature) were combined and evaluated as both soil and sediment in order to be protective of ecological receptors that may utilize the sites during dry and wet conditions, respectively. For the sediment evaluation in these areas, soil samples from the shallow soil interval (0 to 0.5 ft-bgs) and sediment samples were combined to form the sediment dataset used to evaluate aquatic or semi-aquatic exposure scenarios that may occur when the areas are inundated.

4.2 BERA Screening-Level COPEC Criteria

In this step of the screening-level evaluation, exposure to stressors and the relationship between stressor concentrations and ecological effects are evaluated. Maximum concentrations in environmental media (soil, surface water, and sediment) are the EPCs that are compared to corresponding media-specific conservative effects benchmarks. For each exposure area, constituents were selected for further analysis as COPECs if the maximum detected concentration exceeded an ESV. Constituents that were not detected were not retained as COPECs. However, if one-half the MDL for a non-detected constituent exceeded the most conservative screening level, that constituent was retained for further evaluation in the COPEC refinement (**Section 4.4**). Constituents lacking ESVs were not removed as COPECs at the initial screening stage but were carried forward for evaluation in the COPEC refinement. Constituents that also lacked refined ESVs were discussed in the COPEC refinement uncertainty section.

Consistent with the original Site SLERA (Roux, 2017b), the ESVs for this screening-level COPEC identification step were gathered from the following sources, as detailed in the RI/FS Work Plan (Roux, 2015a) or otherwise requested by USEPA, for each media type:

- Soil
  - USEPA Ecological Soil Screening Levels (USEPA, 2005b)
  - Los Alamos National Laboratory (LANL) ECORISK Database (LANL, 2017)
  - *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates* (Efroymson et al., 1997a)
  - *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants* (Efroymson et al., 1997b)
  - Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels (USEPA, 2003b)
- Surface Water:
  - USEPA National Recommended Water Quality Criteria (USEPA, 2019)
  - Montana Department of Environmental Quality (MDEQ) Circular DEQ-7 (MDEQ, 2017)
  - *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota* (Suter and Tsao, 1996)
  - USEPA Region 3 Freshwater Screening Benchmark (USEPA, 2006a)
  - Canadian Water Quality Guidelines, Summary Table (CCME, 2008)
- Sediment:
  - Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (MacDonald et al., 2000)
  - USEPA Region 3 Freshwater Sediment Screening Benchmarks (USEPA, 2006b)
  - *Calculation and evaluation of sediment effect concentrations for the amphipod Hyalella azteca and the midge Chironomus riparius* (Ingersoll et al., 1996)
  - Region 5 RCRA Ecological Screening Levels (USEPA, 2003b)

The minimum ESV from these sources was selected as the benchmark criterion for the selection of screening-level COPECs. A comprehensive summary of all the soil, surface water, and sediment ESVs used during this evaluation are provided in **Appendix B**. Because chromium speciation data were used to estimate relative concentrations of Cr(III) and Cr(VI) in all soil samples (**Section 4.1.1.2**), soil ESVs based on trivalent chromium were used for comparison to total and estimated Cr(III) concentrations, and soil ESVs based on hexavalent chromium were used for comparison to Cr(VI) concentrations.

Surface water ESVs are based upon chronic toxicity values and applied based on the filtered (dissolved) or unfiltered (total) fraction in accordance with the basis of the minimum ESV selected for each constituent. ESVs were based on dissolved criteria for metals with dissolved criteria promulgated as National Recommended Water Quality Criteria (NRWQC); ESVs were also evaluated based on total criteria for metals, except for aluminum, consistent criteria promulgated in MDEQ Circular 7 (MDEQ, 2017). Hardness- or pH- dependent surface water ESVs shown in **Appendix B** for ammonia, cadmium, lead, nickel, and zinc were calculated using sample-specific hardness values, consistent with the BERA Work Plan. The resulting calculations for these sample-specific adjustments are presented in **Appendix D.**

As specified in the SLERA, when evaluating each pathway, maximum constituent concentrations measured in soil, surface water, and sediment within each exposure area were compared to the lowest identified ESV obtained from the above sources. By using maximum concentrations in the environmental media (soil, surface water, and sediment) and the lowest screening benchmarks, the initial COPEC screening evaluation is designed to minimize chances of eliminating a COPEC from further consideration when it may pose an actual ecological risk. Thus, the resulting risk calculation is expected to be an overestimate of actual risk (USEPA, 1997).

If the maximum concentration of a constituent exceeded the most conservative ESV, the COPEC was retained for further evaluation in the ecological risk assessment process. If the maximum concentration was less than the ESV, this indicates that adverse effects are not likely, and the analyte can be eliminated from further investigations.

4.3 Screening-Level Selection of COPECs

The full compilation of screening-level selection tables for all exposure areas and media are presented in **Appendix B**. A summary table of the results is presented in **Table 4-14** for soil and sediment, and **Table 4-15** for surface water. The results of the initial screening-level selection of COPECs for all exposure areas are discussed in the following subsections. Constituents were identified as screening-level COPECs if their maximum detected concentration exceeded the minimum screening ESV, or if no ESV was available.

4.3.1 Terrestrial Exposure Areas

The results of the screening-level COPEC selection process are described below for soil in the seven terrestrial exposure areas at the Site.

4.3.1.1 Main Plant Area

For the Main Plant Area, 25 inorganics (including metals, other inorganic parameters, and essential nutrients), 14 individual PAH compounds, both LMW and HMW PAH categories, 7 non-PAH SVOCs, 6 VOCs, dioxins, and 1 PCB were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.1.2 Central Landfills Area

For the Central Landfills Area, 25 inorganics (including metals, other inorganic parameters, and essential nutrients), 15 individual PAH compounds, both LMW and HMW PAH categories, 8 non-PAH SVOCs, 6 VOCs, dioxins, and 1 PCB were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.1.3 Industrial Landfill Area

For the Industrial Landfill Area, 25 inorganics (including metals, other inorganic parameters, and essential nutrients), 10 individual PAH compounds, and both LMW and HMW PAH categories were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.1.4 Eastern Undeveloped Area

For the Eastern Undeveloped Area, 21 inorganics (including metals, other inorganic parameters, and essential nutrients), 2 individual PAH compounds, HMW PAHs, and 4 non-PAH SVOCs were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.1.5 North-Central Undeveloped Area

For the North-Central Undeveloped Area, 20 inorganics (including metals, other inorganic parameters, and essential nutrients), HMW PAHs, 2 non-PAH SVOCs, and 1 VOC were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.1.6 Western Undeveloped Area

For the Western Undeveloped Area, 22 inorganics (including metals, other inorganic parameters, and essential nutrients), HMW PAHs, 3 non-PAH SVOCs, 4 VOCs, and dioxins were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.1.7 Flathead River Riparian Area

For the Flathead River Riparian Area, 17 inorganics (including metals, other inorganic parameters, and essential nutrients), 1 individual PAH compound, HMW PAHs, 3 non-PAH SVOCs, and 5 VOCs were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.2 Incremental Soil Sampling Area

For the Incremental Soil Sampling Area, the initial COPEC selection step was performed using Operational Area data comprised of the three scenarios described in **Section 4.1.1.1**. This data set was comprised of the UCL concentrations from the DUs with triplicate ISS samples, plus 1.) results from non-triplicate DUs adjusted high using the RSD adjustment factor, 2.) the original measured concentrations in the non-triplicate DUs, and 3.) results from non-triplicate DUs adjusted low using the RSD adjustment factor. Only the high-adjusted dataset was used to select screening-level COPECs in the ISS area soil. 26 inorganics (including metals, other inorganic parameters, and essential nutrients), 16 individual PAH compounds, LMW and HMW PAHs, 8 non-PAH SVOCs, and 2 PCBs were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3 Transitional Exposure Areas

The results of the screening-level COPEC selection process are described below for soil and sediment in the four transitional exposure areas at the Site.

4.3.3.1 North Percolation Pond Area

4.3.3.1.1 Soil

For the North Percolation Pond Area, 26 inorganics (including metals, other inorganic parameters, and essential nutrients), 16 individual PAH compounds, both LMW and HMW PAH categories, 4 non-PAH SVOCs, and 6 VOCs were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3.1.2 Surface Water

For the North Percolation Pond Area, 19 inorganic constituents (including both total and filtered fractions) and 9 PAHs were identified as screening-level COPECs in surface water. These constituents were carried forward for COPEC refinement, as described in **Section 4.4**.

4.3.3.1.3 Sediment

For the North Percolation Pond Area, 23 inorganics (including metals, other inorganic parameters, and essential nutrients), 17 individual PAH compounds, Total PAHs, and 3 non-PAH SVOCs were identified as screening-level COPECs in sediment. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3.2 South Percolation Pond Area

4.3.3.2.1 Soil

For the South Percolation Pond Area, 24 inorganics (including metals, other inorganic parameters, and essential nutrients), 2 individual PAH compounds, HMW PAHs, 5 non-PAH SVOCs, and 5 VOCs were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3.2.2 Surface Water

For the South Percolation Pond Area, 26 inorganic constituents (including both total and filtered fractions) and 3 PAHs were identified as screening-level COPECs in surface water. These constituents were carried forward for COPEC refinement, as described in **Section 4.4**.

4.3.3.2.3 Sediment

For the South Percolation Pond Area, 19 inorganics (including metals, other inorganic parameters, and essential nutrients), 13 individual PAH compounds, Total PAHs, 5 non-PAH SVOCs, and 5 VOCs were identified as screening-level COPECs in sediment. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3.3 Cedar Creek Overflow Ditch

4.3.3.3.1 Soil

For the Cedar Creek Reservoir Overflow Ditch Area, 18 inorganics (including metals, other inorganic parameters, and essential nutrients), 1 individual PAH compound, HMW PAHs, and 3 non-PAH SVOCs were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3.3.2 Surface Water

For the Cedar Creek Reservoir Overflow Ditch Area, 10 inorganic constituents (including both total and filtered fractions) were identified as screening-level COPECs in surface water. These constituents were carried forward for COPEC refinement, as described in **Section 4.4**.

4.3.3.3.3 Sediment

For the Cedar Creek Reservoir Overflow Ditch Area, 13 inorganics (including metals, other inorganic parameters, and essential nutrients), 14 individual PAH compounds, Total PAHs, and 3 non-PAH SVOCs were identified as screening-level COPECs in sediment. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3.4 Northern Surface Water Feature

4.3.3.4.1 Soil

For the Northern Surface Water Feature Area, 18 inorganics (including metals, other inorganic parameters, and essential nutrients) and 1 non-PAH SVOC were identified as screening-level COPECs in soil. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.3.4.2 Surface Water

For the Northern Surface Water Feature Area, 10 inorganic constituents (including both total and filtered fractions) were identified as screening-level COPECs in surface water. These constituents were carried forward for COPEC refinement, as described in **Section 4.4**.

4.3.3.4.3 Sediment

For the Northern Surface Water Feature Area, 14 inorganics (including metals, other inorganic parameters, and essential nutrients), 10 individual PAH compounds, Total PAHs, and 4 non-PAH SVOCs were identified as screening-level COPECs in sediment. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.4 Aquatic Exposure Areas

The results of the screening-level COPEC selection process are described below for surface water and sediment in the two aquatic exposure areas at the Site.

4.3.4.1 Flathead River

4.3.4.1.1 Surface Water

For the Flathead River, 16 inorganic constituents (including both total and filtered fractions), 11 PAHs, and 2 non-PAH SVOCs were identified as screening-level COPECs in surface water. These constituents were carried forward for COPEC refinement, as described in **Section 4.4**.

4.3.4.1.2 Sediment

For the Flathead River, 8 inorganics (including metals, other inorganic parameters, and essential nutrients), 14 individual PAH compounds, Total PAHs, 4 non-PAH SVOCs, and 5 VOCs were identified as screening-level COPECs in sediment. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.3.4.2 Cedar Creek

4.3.4.2.1 Surface Water

For Cedar Creek, 10 inorganic constituents (including both total and filtered fractions) were identified as screening-level COPECs in surface water. These constituents were carried forward for COPEC refinement, as described in **Section 4.4**.

4.3.4.2.2 Sediment

For Cedar Creek, 9 inorganics (including metals, other inorganic parameters, and essential nutrients), 12 individual PAH compounds, Total PAHs, and 2 non-PAH SVOCs were identified as screening-level COPECs in sediment. These constituents were carried forward to the refinement COPEC selection step described in **Section 4.4**.

4.4 Refined COPEC Screening Process

Following the initial selection of screening-level COPECs, a refined COPEC screening process was conducted to preliminarily identify focal COPECs that may influence the BERA. The refined COPEC screening process considers alternative ESVs and other criteria for COPECs identified in the conservative SLERA screening process. A fundamental step in the baseline problem formulation is the refinement of COPECs to identify those constituents that are most likely to drive risk management decision-making for the Site. The intent of the refinement step is to focus and streamline the overall ERAGS process. COPEC refinement in the BERA problem formulation is consistent with USEPA *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001a). Specific elements of COPEC refinement include consideration of the following:

- Use of refined ESVs: Alternative ESVs that are protective of chronic exposure but represent a broader range of protective NOEC endpoints are considered to provide context for the potential ecological risk associated with COPECs identified in the initial screening step, and to focus evaluation of COPECs in the BERA.
- Background concentrations: COPECs in exposure areas at concentrations that are not significantly different from background concentrations may represent regional conditions that are not related to site activities or are not likely to drive risk in the BERA.
- Frequency of detection: COPECs that are infrequently detected (less than 5 percent) are not likely to ultimately drive risk management decisions in the BERA process. The magnitude of exceedance of ESVs and BTVs was considered as part of the refinement of infrequently detected COPECs.
- Dietary considerations: COPECs that serve as essential nutrients (e.g., calcium, iron, magnesium, sodium, and potassium) typically pose little threat to ecological receptors when present in concentrations that allow them to function as nutrients. As described in **Section 4.4.4** however, calcium received special consideration due to its potential presence at elevated concentrations due to its generation in historical waste streams at the Site.

Each of these criteria are discussed in greater detail in the following sections. Additionally, COPECs retained because they lacked ESVs, or with MDLs exceeding conservative ESVs are re-evaluated in the refined COPEC screening uncertainty section as part of the BERA Problem Formulation.

4.4.1 Refined ESVs

As discussed in **Section 3.2**, the conservative exposure scenario evaluated in the SLERA (maximum exposure concentrations and minimum ESVs) and incorporated into the screening-level COPEC selection in the BERA problem formulation minimizes the potential for COPECs to be dismissed from the screening process prematurely, but does not provide a basis for assessing the potential for adverse effects to occur. Alternative ESVs are used in the COPEC refinement process to be protective of chronic exposure to ecological receptor groups, but also represent a broader range of NOECs than the minimum ESVs used in the conservative initial screening step.

A summary of preliminary ESVs used for the initial BERA screening-level COPEC identification is presented in **Appendix B**. Additional documentation and description of the refined ESVs used for the BERA COPEC refinement is presented in **Table A-1** (soil and sediment) and **Table A-2** (surface water and ground water) in the ESV Interim Deliverable presented in **Appendix A1**. This interim deliverable was prepared for USEPA review to support the selection of revised ESVs from a range of NOECs identified in literature sources. The refined ESVs are used in the COPEC refinement step of the BERA Problem Formulation to re-screen data from each exposure area and exposure medium based on the combined Phase I and Phase II Site Characterization datasets.

For the BERA COPEC refinement, Phase I and Phase II data were grouped by exposure medium, and maximum concentrations were compared to alternative ESVs. For soil, COPEC refinement included comparison of surface (0-0.5 ft) and shallow (0.5-2 ft) soil data from terrestrial and transitional exposure areas, as well as sediment data from transitional exposure areas (as described in **Section 4**) to refined soil ESVs. For surface water, COPEC refinement included comparison of surface water data from aquatic and transitional exposure areas to refined ESVs based on USEPA NRWQC or MDEQ chronic surface water quality for the protection of aquatic life. For sediment, COPEC refinement included comparison of sediment data from aquatic exposure areas, and a combination of surficial (0 to 0.5 ft) soil and sediment from transitional exposure areas (as described in **Section 4.1.3.2**) to refined sediment ESVs. The following sections summarize the refined COPEC screening process. A complete description of the ESVs used for the refined COPEC screen is presented in the refined ESVs interim deliverable presented in **Appendix A1**. The raw data used to perform the BERA is presented in the Phase II DSR (Roux, 2019).

4.4.1.1 Refined Soil ESVs

Refined soil ESVs were derived based on peer-reviewed, multi-trophic level soil screening criteria. The derivation of refined soil screening criteria was based on the USEPA approach for deriving ecological soil screening levels (Eco-SSLs). Eco-SSLs were derived as risk-based soil screening levels through a peer review process for the protection of multiple terrestrial receptor categories (USEPA, 2005b):

- Terrestrial plants
- Soil invertebrates
- Birds
- Mammals

Eco-SSLs are intended for use in the screening process to identify constituents that are not of potential ecological concern and do not need to be considered in the BERA (USEPA, 2005b). Eco-SSLs are considered to be protective of terrestrial ecosystems, including rare, endangered, and threatened species that may be present (USEPA, 2005b). Per Eco-SSL guidance, toxicity of aluminum and iron to terrestrial biota exhibits little correlation to detected concentrations in soil. Rather, the acidity of the soil was found to be a much more reliable indicator of toxic effects. As such, the guidance recommends replacing a numeric screening value associated with constituent toxicity with the measured soil pH. Soils with pH greater than 5.5 for aluminum and 5 for iron are considered to pose little to no risk to ecological receptors. The laboratory-measured pH from 36 soil samples collected across the Site ranged from 7.4 to 9. Therefore, aluminum and iron were excluded as COPECs in soil at all exposure areas.

To supplement established Eco-SSL criteria, endpoints from the multiple terrestrial receptor categories included in the Eco-SSL approach were compiled from the LANL ECORISK Database (Release 4.1; LANL, 2017). The LANL ECORISK Database presents benchmarks that were developed using an approach similar to the derivation of Eco-SSLs, i.e., the guidance selected geometric mean concentrations of NOEC endpoints as the screening criteria for multiple terrestrial receptor foraging guilds, or generic receptor groups, within a specific medium. The minimum of the available LANL and Eco-SSL values for multiple terrestrial receptor foraging guilds or groups was used in the BERA as the refined soil ESV for that constituent to provide for the protection of each receptor group. In the absence of sufficient data to refine soil ESVs based on the Eco-SSL approach, the conservative minimum ESV used in the SLERA was retained.

Avian and mammalian exposures to the mixture of 17 dioxin and furan compounds analyzed in surficial soil samples were evaluated relative to the toxicity of 2,3,7,8-TCDD using TEFs developed for birds and mammals by the WHO (Van den Berg et al., 2006; Van den Berg et al., 1998; USEPA, 2008b). For dioxin and furan screening, measured concentrations of the 17 dioxin and furan compounds in surface soil samples were multiplied by compound specific TEFs to calculate toxicity equivalence concentrations (TECs) for each compound. The summed TECs for each sample were compared to soil concentrations protective of avian and mammalian exposure to 2,3,7,8-TCDD. As discussed in **Section 4.1.1.4**, dioxin and furan concentrations that were below the detection limit were estimated as 0, one-half the MDL, and the MDL. TEC calculations for dioxin and furan samples are provided in **Appendix C**.

Terrestrial plant and soil invertebrate exposures to dioxin and furan compounds were not considered in the screening evaluation since it has been demonstrated that a wide variety of invertebrates and plants are insensitive to dioxin and furan exposure relative to birds and mammals (USEPA, 2008b). However, the LANL ECORISK Ecological Screening Level of 5 mg/kg for 2,3,7,8-TCDD is included in the evaluation of soil-dwelling invertebrate direct contact exposure to dioxin and furan compounds.

In the absence of sufficient data to refine soil ESVs, the conservative minimum ESVs used in the SLERA were retained.

4.4.1.2 Refined Surface Water ESVs

Refined ESVs for surface water were preferentially based on USEPA NRWQC or MDEQ chronic surface water quality for the protection of aquatic life. Chronic aquatic life surface water criteria are derived for the protection of 95 percent of aquatic species. Therefore, these criteria are considered adequately protective to identify COPEC concentrations in surface water that have the potential to result in adverse ecological effects and warrant additional evaluation in the BERA. In the absence of NRWQC or MDEQ criteria, refined ESVs were selected from the sources listed in **Section 4.2** that are protective of chronic exposure.

Refined ESVs were applied to sample results corresponding to the aqueous toxicity data used to establish the chronic aquatic life surface water criteria. For many metals, NRWQC chronic surface water quality criteria are based on exposure to the dissolved phase. For these COPECs, refined ESVs were applied to filtered surface water sample results[2], which operationally represent the dissolved COPEC phase in the sample. MDEQ criteria for metals, except for aluminum, are based on the total result; therefore, MDEQ criteria were applied to unfiltered surface water sample results. If either phase of metal exceeded refined ESVs, the COPEC was retained for further evaluation in the BERA.

Hardness- or pH- dependent refined ESVs were derived on a sample-specific basis for ammonia, fluoride, cadmium, chromium, lead, nickel, zinc, and pentachlorophenol, consistent with the BERA Work Plan. USEPA NRWQC for copper and aluminum are based on models developed to characterize the bioavailable forms of these metals in surface water based on water quality parameters. The NRWQC for copper is based on the USEPA BLM, which accounts for organic compounds and inorganic ligands in surface water that are known to complex with copper and affect bioavailability and toxicity (USEPA, 2007b). For aluminum, the refined ESV is based on recently promulgated (December 2018) USEPA aquatic life ambient water quality criteria developed using multiple linear regression models to characterize aluminum bioavailability based on pH, hardness, and dissolved organic carbon (DOC; USEPA, 2018). The associated calculations for sample-specific adjustments for refined surface water ESVs are presented in **Appendix D.**

In the absence of sufficient data to refine surface water ESVs based on USEPA NRWQC or MDEQ surface water quality criteria, the conservative minimum ESVs used in the SLERA were retained.

[2] Filtered samples were collected in the fourth round of Phase I sampling and in all Phase II sampling rounds.

4.4.1.3 Refined Sediment ESVs

Refined ESVs for sediment were based primarily on consensus-based criteria and equilibrium partitioning-based criteria for PAHs. Consistent with the approach used for refined soil ESVs, refined sediment ESVs for metal COPECs and select organic COPECs were estimated as the geometric mean of NOEC endpoints following the consensus-based approach (MacDonald et al., 2000).

Refined ESVs for PAHs in sediment were based on USEPA *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures* (USEPA, 2003a). ESBs derived in USEPA (2003a) were used to estimate the potential additive narcotic effects of PAH mixtures in sediment based on theoretical partitioning of PAH compounds between organic carbon and pore water. Exposure to the PAH mixture was evaluated based on the sum of equilibrium partitioning sediment benchmark toxic units (∑ESBTUs) calculated from individual PAH compounds:

$$\sum ESBTU_{FCV,Total} = \sum_{i=1}^{13} \frac{C_{oc,PAHi}}{C_{oc,PAHi,FCVi}} \times UF$$

where:

$\sum ESBTU_{FCV,Total}$	= Sum of ESBTUs for the PAH mixture based on 34 PAH compounds (unitless)
$C_{oc,PAHi}$	= Organic carbon normalized concentration of PAH *i* (µg/g_{oc})
$C_{oc,PAHi,FCVi}$	= Organic carbon normalized critical concentration of PAH *i* based on the final chronic value (FCV; µg/g_{oc})
UF	= Uncertainty factor to estimate the toxicity of total PAHs (based on 34 PAHs – 18 parent and 16 alkylated compounds)

Sediment samples collected in the Phase I and II Site Characterization were analyzed for 13 or 34 PAH compounds included in the USEPA ESB model. For samples analyzed for 13 PAHs compounds, an uncertainty factor of 2.75 was applied to account for the potential toxicity of unmeasured PAHs in the ∑ESBTU calculation (USEPA, 2003a). Some sediment samples in the Flathead River Riparian and Northern Percolation Pond transitional areas, and the Flathead River aquatic exposure area were also analyzed during Phase II for a broader suite of PAHs using the SIM analytical method 8270D SIM. This method analyzes for 34 PAHs (18 parent and 16 alkylated compounds). For these samples, ∑ESBTU values were calculated without the use of an uncertainty factor. Method 8270D SIM data were used preferentially over the non-SIM PAH results, when available. ∑ESBTU values less than or equal to 1.0 are considered acceptable for the protection of benthic invertebrate receptors; values exceeding 1.0 indicate a potential for narcotic effects in benthic receptors (USEPA, 2003a). ∑ESBTU values greater than 10 result in more frequent adverse effects to benthic test organisms.

Several non-PAH nonionic organic constituents were identified as screening-level COPECs in sediment in transitional and aquatic exposure areas, including 3- and 4-methylphenol, 4-chloroaniline, benzaldehyde, bis(2-ethylhexyl)phthalate (BEHP), carbazole, acetophenone, dibenzofuran, and phenol. ESBs for these constituents were developed using the EqP approach described in *Procedures for the*

Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Compendium of Tier 2 Values for Nonionic Organics (USEPA, 2008a). ESB values represent concentrations of nonionic organic constituents in bulk sediment that, at equilibrium, would result in partitioning to sediment pore water at concentrations equivalent to NOEC water quality benchmarks (WQB_{NOEC}). ESB_{NOEC} values for nonionic constituents were calculated using chronic $WQBs_{NOEC}$ and constituent-specific organic carbon-water partitioning coefficients (K_{oc}):

$$ESB_{NOEC} = (f_{oc} \times K_{oc} \times WQB_{NOEC})$$

where:

ESB_{NOEC}	= Equilibrium-partitioning sediment benchmark based on NOEC aqueous toxicity data (microgram per kilogram [µg/kg] dw sediment)
f_{oc}	= Fraction of organic carbon in sediment
K_{oc}	= Organic carbon-water partitioning coefficient (liter per kilogram [L/kg])
WQB_{NOEC}	= Water quality benchmark based on a chronic NOEC (microgram per liter [µg/L])

If available, appropriate WQB_{NOEC} values were identified from the preliminary ESVs for surface water (**Appendix B**). Constituent-specific organic carbon-water partitioning coefficient (K_{oc}) values were calculated as a function of K_{ow}. Constituent-specific values for K_{ow} were obtained from EPA Estimation Programs Interface (EPI) Suite database. K_{oc} values were estimated based on constituent-specific K_{ow} values based on the following relationship (USEPA, 2008a; Di Toro et al, 1991):

$$\log K_{oc} = 0.0028+0.983 \times (\log K_{ow})$$

where:

$\log K_{oc}$ = log organic carbon-normalized sediment quality benchmark (L/kg)
$\log K_{ow}$ = log octanol-water partition coefficient (unitless)

Equilibrium partitioning-based benchmark calculations for non-PAH and PAH constituents are presented in **Appendix F** and **Appendix G**, respectively. In the absence of consensus-based or equilibrium partitioning approaches, refined sediment ESVs were selected from the sources listed in **Section 4.2** that are protective of chronic exposure. If sufficient data were not available to refine sediment ESVs, the conservative minimum ESV used in the SLERA was retained.

4.4.2 Background Evaluation

As described in the *Background Investigation Sampling and Analysis Plan* (Roux, 2018b), soil background samples were collected from four nearby terrestrial areas with soil types that match those found at the Site. Surface water and sediment background samples were collected from two aquatic reference areas upgradient of the influence of any potential Site waste streams. Data from these samples were used to calculate general statistics on background constituents, including BTVs that are intended to represent upper-bound background concentrations. The methods and results of these calculations are presented in (Roux, 2019).

Following the procedures outlined in the Background SAP (Roux, 2018b), for exposure areas except the ISS grid (i.e., the Operational Area), UCL_{mean} concentrations for constituents detected in the on-site ecological exposure areas were compared to the mean background concentration for the constituents derived from the reference area samples as an initial evaluation as to whether the constituent was background-related. The UCL_{mean} concentrations were calculated only for site data obtained from the shallow (0 to 0.5 ft-bgs) soil samples to match the depths of soils collected in the background reference area (Roux, 2018b and 2019). USEPA ProUCL software (version 5.1; USEPA, 2015b) was used to calculate the on-site statistics for comparison to background. Occasionally, ProUCL recommended a UCL_{mean} based on the H-statistic method, which often results in an impractically large UCL value. Based on general recommendations in the ProUCL User's Guide (USEPA, 2015b), an alternate calculated UCL_{mean} (usually the Chebyshev 95 percent UCL_{mean}) was selected for use for that constituent. ProUCL output and summary statistics are presented in **Appendix I.** Because the ISS grid consists of a combination of UCLs calculated for the DUs with triplicate data and single ISS sample data adjusted based on the RSD of the DUs with triplicates (see **Section 4.1.1.1**), developing an Operational Area-wide UCL value to compare against the mean background concentrations is not statistically appropriate, as the concentrations from the individual DUs have varying statistical properties and underlying assumptions. Therefore, comparisons to background concentrations were not used as a criterion for refining COPECs in the Operational Area ISS grid.

Table 4-16 presents the background reference areas that were selected for comparison to the terrestrial, transitional, and aquatic exposure areas. The selection of reference areas for the aquatic exposure areas is straightforward; constituents detected in surface water and sediment in the Flathead River and Cedar Creek aquatic exposure areas were compared with concentrations in the upgradient Flathead River and Cedar Creek reference areas, respectively. For soil, four background reference areas were established (SO#1, SO#2, SO#3, and SO#4) that reflected soil types found on-site. The background dataset for the reference area that had the most similar soil type to the exposure area being investigated was selected for the background comparison in this BERA. The Flathead Valley in the vicinity of the site is comprised of three primary soil types: 1) Glacial Till and Alluvium (soils deposited by glacial activity); 2) Fluvial Deposits and Riverwash (soils deposited by river activity); and 3) Mountainous Land with Glacial Deposits, which is expressed at the surface as Teakettle Mountain (soil interaction between the glacial outwash and bedrock) (Roux, 2018b). Although most ecological exposure areas near the facility were comprised of glacial till and alluvium, the mountainous land will glacial deposits soil type had a minor presence (e.g., less than approximately 10 percent spatial coverage) at a few of the areas. In these cases, the soil reference area that represented the dominant soil type at the exposure area was selected for the background evaluation. In all terrestrial and transitional soil areas, except for the Flathead River Riparian Area and the South Percolation Pond Area, the dominant soil type was influenced by glacial till and alluvium most similar to soil from background reference area SO#1. The Flathead River Riparian Area and the South Percolation Pond Area are both located in soil types dominated by alluvial deposits. Two background reference areas (SO#2 and SO#3) were collected in soil types similar to these two exposure areas. The lower of these two background concentrations was selected as the mean concentration for comparison to the UCL_{mean} of concentrations detected in the Flathead River Riparian Area and the South Percolation Pond Area.

As described in **Section 4.1.1**, soil and sediment samples collected from transitional exposure areas were evaluated both as soil and as sediment to account for protecting the different receptor communities that may use the areas during dry periods and during inundation. The underlying soil type guided the selection of the background soil reference area for the soil comparison, as discussed above. For the sediment comparison, the Cedar Creek Reservoir Overflow Ditch transitional area has an upgradient connection to Cedar Creek; therefore, the Cedar Creek background sediment data were used for the sediment evaluation in this exposure area. The North and South Percolation Ponds and the Northern

Surface Water Feature transitional exposure areas are hydrologically isolated from the two aquatic reference areas in the Flathead River and Cedar Creek. The transitional sediment/soil areas represent process-driven depressions where organic material and fines are likely to have been deposited. Thus, the substrates in these areas have characteristics that make a comparison to background concentrations derived from stream and river systems inappropriate. Therefore, the background soil reference area selected for the soil comparison in these three transitional exposure areas were also used for the sediment comparison.

Surface water in the transitional exposure areas was compared to background reference data from the most appropriate aquatic reference water body based on proximity, overland flow patterns, and regional drainage characteristics. Based on this evaluation, surface water from the North Percolation Pond Area, Cedar Creek Reservoir Overflow Ditch, and the Northern Surface Water Feature were compared to surface water reference data from Cedar Creek. Surface water from the South Percolation Pond Area was compared to surface water reference data from the Flathead River.

Constituents in each exposure area with 95 percent UCL_{mean} concentrations below the mean background concentration were not retained as COPECs (Roux, 2018b). However, constituents excluded as COPECs based on this comparison, with maximum detected concentrations exceeding refined ESVs, are discussed further in the COPEC selection uncertainty section (**Section 4.6**). Constituents with 95 percent UCL_{mean} concentrations exceeding the mean background concentration were subjected to a secondary background evaluation consisting of a two-sample hypothesis test to determine if the site and background populations are significantly different (Roux, 2018b). If the site concentrations are determined to be from a different population, and the mean (or median) is greater than that of the background data plus the significant difference (1.3 times the standard deviation), then the constituent was considered to be a COPEC. Otherwise, the constituent was considered to be background-related. When two reference areas were available for either soil or sediment in a given exposure area (e.g., SO#2 and SO#3 were selected as appropriate reference areas for Flathead River Riparian Area; see **Table 4-16** and Roux, 2019) a two-sample hypothesis test was separately performed for each constituent using data from both sets of reference areas. If the result of either test indicated that the populations were not significantly different between the site and reference area, then the constituent was considered to be background-related. The results of the two-sample hypothesis testing are summarized in the COPEC refinement tables and presented in full in the Phase II DSR (Roux, 2019).

4.4.3 Frequency of Detection

Constituents that are detected infrequently may be artifacts in the data that may not reflect site-related activity or disposal practices. These constituents are not evaluated further in the risk evaluation. Generally, constituents that are detected only at low concentrations in less than 5 percent of the samples (if more than 20 samples were analyzed) were initially eliminated from further consideration. Constituents detected infrequently at elevated concentrations as compared with ESVs and/or BTVs may indicate the presence of “hot spots” and may be retained in the evaluation. The maximum detected concentrations of constituents that were detected in less than 5 percent of samples were compared to a value equal to 10-times the ESV or BTV for that constituent, whichever is greater. Although no recommendation on hot spot identification was identified in MDEQ guidance, this approach is consistent with environmental guidance on identification of hot spots in other states. For example, the Land Quality Division in the state of Oregon (State of Oregon Department of Environmental Quality, 1998) defines a soil hot spot as an area where a constituent is present at 10 times the acceptable risk level (or up to 50 times the risk level for non-threatened or endangered species). The New Jersey Site Remediation Program (New Jersey Department of Environmental Protection, 2018) lists one of its criteria for hot spots as areas where "the magnitude of the exceedance is substantial (e.g., more than 10 times the ecological screening criteria or background concentrations)". If the maximum detected concentration exceeded this value, exceedances were plotted on a map. Professional judgment was used to evaluate whether the exceedances were spatially clustered, such that regular exposure could occur in a localized, but ecologically relevant portion of the site. Infrequently detected constituents that meet these criteria were retained as refined COPECs and evaluated for risk associated with direct contact and wildlife ingestion exposure pathways.

The frequency of detection criterion was not used in the COPEC refinement step for the Operational Area. The individual DUs that comprise the ISS sampling grid represent independent exposure areas; therefore, it is not appropriate to exclude constituents as refined COPECs that occur in a low percentage of DUs because localized disposal practices could have resulted in the site-related presence of a given constituent in a single DU. Also, small range receptors could realistically receive all (or nearly all) of their exposure within one DU; thus, the elimination of a COPEC detected in a low percentage of samples because it would be infrequently encountered by a receptor is not a valid assumption for the Operational Area, where each "sample" represents an area that is approximately 1 acre in size.

4.4.4 Nutrient Status

As described in Supplemental Component 3 of *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, 2001a), physiological electrolytes (e.g., iron, magnesium, sodium, and potassium) or macro and micro-nutrients (e.g., nitrogen, phosphorus, and copper) are considered in the broader context of their essential role in performing intracellular functions in aquatic and terrestrial flora and fauna. Within the soil, surface water, and sediment matrices evaluated as part of the ecological investigation, several constituents require further discussion pertaining to dietary considerations. Anions, cationic metals, and nutrient constituent groups are discussed below for each matrix evaluated. The anion chloride is discussed, as well as the cationic metals sodium, potassium, calcium, and magnesium. Nutrients, measured in surface water, include nitrate/nitrite-nitrogen, ammonium-nitrogen, and total orthophosphate-phosphorus. Most nutrients, cationic metals, and anions lacked ESVs in the initial COPEC screening evaluation. However, these constituents were included as they provide important ancillary information that can refine exposure criteria (e.g., BLM in surface waters) or further characterize exposure to identified COPECs. The role of these constituents as essential components of specialized intracellular functions is discussed below.

Cationic metals, including calcium, magnesium, potassium, and sodium, were evaluated in sediment and soil matrices. The range of observed constituent concentrations and means across exposure areas in site surface soil (0 to 2 ft-bgs) and sediment was compared to BTVs developed for the Site and to the range of typical values for western soils described in *Element Concentrations in Soils and other Surficial Materials of the Conterminous United States* (USGS, 1984):

Cationic Metal	CFAC Site	CFAC Site, Range of Means	CFAC Background (Range of BTVs)	Western U.S. Soils (USGS, 1984)	
	Concentration Range (mg/kg)	Concentration Range (mg/kg)	Concentration Range (mg/kg)	Geomean ± GSD Concentration (mg/kg)	Concentration Range (mg/kg)
Calcium	427 to 313,000	8,152 to 125,544	16,691 to 47,061	18,000 ± 30,500	600 to 320,000
Magnesium	442 to 27,500	6,329 to 10,607	8,275 to 16,202	7,400 ± 22,100	300 to 100,000
Potassium	101 to 10,900	678 to 1,797	1,844 to 2,167	18,000 ± 7,100	1,900 to 63,000
Sodium	26.5 to 61,300	58 to 11,037	69.94 to 293.3	9,700 ± 19,500	500 to 100,000

BTV = background threshold value
CFAC = Columbia Falls Aluminum Company, LLC
GSD = geometric standard deviation
mg/kg = milligrams per kilogram
USGS = United States Geological Survey
USGS. (1984). Element Concentrations in Soils and other Surficial Materials of the Conterminous United States. USGS Professional Paper 1270.

The range of site surficial soils and sediments exceeded the range of BTVs for all nutrients, which is not unexpected given the substantial disparity in sample size between the Site (n greater than 550) and the background (n = 10 per soil background area) datasets. With such a large sample size, the opportunity for sampling naturally occurring nutrients in a highly concentrated "nugget" in the soil matrix is high. A comparison of the mean concentrations to each exposure area reveals that with the exception of calcium, all mean ranges were below site BTVs. The range of detected concentrations for these four nutrients also fell within the geometric mean ± geometric mean standard deviation (GSD) for western conterminous U.S. soils for all cationic metals except calcium and sodium. Calcium concentrations above the upper GSD of the geometric mean for western conterminous U.S. soils were noted in soils and sediments from the South Percolation Pond Exposure Area. Only two results for sodium fell outside of the geometric mean ± GSD for western conterminous U.S. soils, and both results were well within the overall concentration range of western U.S. soils.

Calcium was not eliminated outright as a nutrient in the BERA because of its association with fluoride in fluorite (CaF_2). Fluorite is a component of feedstocks used in smelting. Thus, calcium warrants special consideration before eliminating it as a potential COPEC due its presence in a process-related material. As noted in the evaluation above, calcium was detected in site soil and sediment at elevated concentrations compared to site-specific BTVs, and only marginally within the broad concentration range of western U.S. soils. The highest mean concentration of calcium within the evaluated exposure areas occurred at the South Percolation Pond Area (mean = 125,543 mg/kg). All other exposure areas were below the maximum site-specific background BTV of 47,061 mg/kg. Thus, with the exception of the South Percolation Pond Area, the average concentration of calcium that ecological receptors are exposed to does not exceed a representative background concentration from naturally occurring areas in the vicinity of the Site. Toxicity data are generally unavailable for constituents that are essential nutrients and for that reason additional characterization of toxic effects of these constituents is challenging; therefore, calcium is not carried forward as a COPEC, but elevated levels of calcium in the South Percolation Pond Area will be discussed further in the BERA uncertainty analysis (**Section 7**).

In surface water, several essential anion, cationic metals, and nutrient constituents were measured as part of the Phase I and Phase II investigation. Calcium, chloride, magnesium, potassium, and sodium were evaluated, as well as ammonium-nitrogen, nitrate/nitrite-nitrogen, and total orthophosphate nutrients. These anions, cationic metals, and nutrients are particularly important for algal growth (Ansari and Gills, 2014). With the exception of two results for total calcium and one result for dissolved calcium in the South Percolation Pond Area, no exceedances of ESVs were noted for the anion or cationic metal compounds. Anionic and cationic metals data were collected in the Phase I and II Site Characterization for the purposes of evaluating metal constituent bioavailability (e.g., copper) using the BLM, if deemed necessary.

A summary of total (T) and dissolved (D) nutrients in surface water at the Site compared with reference areas is provided in the following table. Although maximum concentrations of all nutrients were well above BTVs, the range of mean concentrations of all nutrients approximated the range of BTVs identified in reference areas, with the exception of sodium, which had means for both total and dissolved fractions that exceeded the highest BTV in four of the six exposure areas (South Percolation Pond Area, Northern Surface Water Feature, North Percolation Pond Area, and the Flathead River) where surface water data were collected.

Cationic Metal	CFAC Site	CFAC Site, Range of Means	CFAC Background (Range of BTVs)
	Concentration Range (µg/L)	Concentration Range (µg/L)	Concentration Range (µg/L)
Calcium (T)	7,860 to 506,000	28,266 to 73,042	27,776 to 55,600
Calcium (D)	7.020 to 147,000	7,020 to 55,073	23800 to 61,264
Magnesium (T)	804 to 63,900	6,510 to 17,100	7,455 to 17,601
Magnesium (D)	384 to 24,600	384 to 15,859	5,990 to 15,852
Potassium (T)	242 to 9,100	367 to 1,426	463 to 919
Potassium (D)	237 to 9,310	389 to 1,518	354 to 751
Sodium (T)	666 to 108,000	1,410 to 19,279	1,232 to 3,064
Sodium (D)	554 to 169,000	1,730 to 18,653	809 to 2,801

µg/L = micrograms per liter
BTV = background threshold value
CFAC = Columbia Falls Aluminum Company, LLC
D = dissolved
T = total

MDEQ developed phosphorus and nitrogen nutrient criteria for wadable streams (MDEQ, 2013) that have been reviewed and accepted by the USEPA. Cedar Creek, the only applicable water body for the criteria, did not have any exceedances for nitrogen or phosphorus compounds. The Flathead River is considered a large river under the numeric criteria framework developed by MDEQ. Large rivers require process-based mechanistic water quality models to determine appropriate criteria (MDEQ, 2013). No orthophosphate-phosphorus or nitrogen compounds were detected in the main stem of the Flathead River at levels that exceeded the criteria. Concentrations of nitrate/nitrite-nitrogen were greater than the criteria for wadeable streams in samples collected along the channel margin of the Flathead River within the Backwater Seep Sampling Area. However, elevated concentrations observed in these samples are typical of mean groundwater nitrate concentrations in shallow groundwater within the Flathead Valley (McDonald and LaFave, 2004).

Based on analyses of the combined Phase I and Phase II Site Characterization datasets, essential nutrients were removed from further consideration in the COPEC refinement conducted as part of the BERA Problem Formulation. Elevated levels of calcium and sodium are discussed in the uncertainty analysis (**Section 7**).

4.4.5 Bioaccumulative Constituents and Food Chain Effects

Detected constituents that were not were not eliminated as COPECs because they were background-related, detected infrequently, or essential nutrients were retained for evaluation of food chain effects if they were classified as bioaccumulative. COPECs with the potential to bioaccumulate were identified for further evaluation in dietary exposure modeling based on satisfying one or more of the following criteria:

- Constituents identified as Persistent, Bioaccumulative, and Toxic Constituents as part of the USEPA Toxics Release Inventory (TRI) Program
- Constituents identified as important bioaccumulative constituents in *Bioaccumulation Testing and Interpretation for Sediment Quality Assessment* (USEPA, 2000b)
- Organic constituents with log octanol-water partitioning coefficient (log K_{ow}) values greater than 3.5 based on USEPA (2000b)
- Constituents with USEPA Eco-SSLs derived for birds or mammals

Thus, detected constituents that exceeded refined ESVs or that were determined to be bioaccumulative, and that were not removed as COPECs for one or more of the other refinement criteria were carried forward for additional evaluation. The results of the COPEC refinement are presented in the following sections.

4.4.6 Chromium

As described in **Section 4.1.1.2**, concentrations of Cr(VI) and Cr(III) were estimated using a ratio developed from site-specific Cr(VI) and total chromium data from a subset of soil samples collected during Phase II. Cr(VI) was detected in 3 of the 20 samples designated for this evaluation and was determined to comprise a less than 3 percent of total chromium in soil samples analyzed at the site. There is a high degree of uncertainty in the resulting estimations of Cr(VI) that were calculated at each exposure area using this ratio because over 85 percent of the samples analyzed for Cr(VI) used to develop the ratio were non-detect. The low proportion of Cr(VI) comprising total chromium was not unexpected, as chromium is present primarily in the Cr(III) oxidation state under typical soil conditions (USEPA, 2008c), and no known historical processes existed that would have introduced Cr(VI) into the environment at the CFAC facility. Cr(VI) toxicity data that may be used to estimate potential impacts to ecological receptors, particularly lower trophic-level organisms that comprise the base of the food chain, are limited because most sources of information used to characterize toxic effects are based on total chromium or Cr(III). USEPA Eco-SSL guidance presents toxicity reference values (TRVs) for Cr(III) and Cr(VI) for mammalian receptors, but only Cr(III) TRVs are available for birds. The mammalian TRV for Cr(III) from this guidance of 2.4 mg/kg-body weight (bw) per day (d) is lower (more conservative) than the TRV for Cr(VI) 9.24 mg/kg bw per day. The LANL ECORISK dataset presents TRVs for Cr(VI) for both birds (11 mg/kg-d) and mammals (9.24 mg/kg-d), both of which are less conservative than the TRVs used to evaluate total chromium in the BERA (see Table 7 in **Appendix A2**). Thus, the evaluation of Cr(III) is protective of any Cr(VI) present in the environment for wildlife receptors. Therefore, as a simplified approach, although estimated (and measured, when available) Cr(VI) and Cr(III) concentrations are presented in the COPEC refinement tables for soil for each exposure area, these oxidation states of chromium are not carried forward separately as COPECs evaluated for ecological risk characterization. Only total chromium is carried forward as a refined COPEC for those exposure areas where it failed one or more of the refinement criteria, and subsequent evaluation of potential toxic effects of this metal are based on total chromium rather than speciated and estimated Cr(III) and Cr(VI) concentrations.

4.5 Refinement of COPECs

The full compilation of refined COPEC selection tables for all exposure areas and media are presented in **Appendix E**. A summary table of the results is presented in **Tables 4-17** (soil and sediment) and **4-18** (surface water). The results of the refined selection of COPECs for all exposure areas are discussed in the following subsections.

4.5.1 Terrestrial Exposure Areas

4.5.1.1 Main Plant Area

For the Main Plant Area, 13 inorganics (including metals and other inorganic parameters), dioxins, 14 individual PAH compounds and both LMW and HMW PAH categories, 2 SVOCs, and 5 VOCs were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.1.2 Central Landfills Area

For the Central Landfills Area, 14 inorganics (including metals and other inorganic parameters), dioxins, 1 PCB, 15 individual PAH compounds and both LMW and HMW PAH categories, 4 SVOCs, and 4 VOCs were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.1.3 Industrial Landfill Area

For the Industrial Landfills Area, 16 inorganics (including metals and other inorganic parameters), 9 individual PAH compounds and both LMW and HMW PAH categories were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.1.4 Eastern Undeveloped Area

For the Eastern Undeveloped Area, 13 inorganics (including metals and other inorganic parameters), 1 individual PAH compound and the HMW PAH category, and 2 SVOCs were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.1.5 North-Central Undeveloped Area

For the North-Central Undeveloped Area, 9 inorganics (including metals and other inorganic parameters), HMW PAHs, 1 SVOC, and 1 VOC were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.1.6 Western Undeveloped Area

For the Western Undeveloped Area, 9 inorganics (including metals and other inorganic parameters), dioxins, HMW PAHs, 1 SVOC, and 4 VOCs were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.1.7 Flathead River Riparian Area

For the Flathead River Riparian Area, 7 inorganics (including metals and other inorganic parameters), 1 individual PAH compound and the HMW PAH category, 3 SVOCs, and 5 VOCs were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.2 Incremental Soil Sampling Grid

As for the screening-level COPEC selection, the high-RSD adjusted dataset was used to select refined COPECs in the ISS area soil. For the Incremental Soil Sampling Grid, 18 inorganics (including metals and other inorganic parameters), 2 PCBs, 16 PAHs (and LMW and HMW PAHs), and 5 SVOCs were identified as refined COPECs in soil. These constituents were evaluated only for potential impacts associated with direct contact (plants and invertebrates), and for comparison to benchmark values protective of small range wildlife receptors.

4.5.3 Transitional Exposure Areas

4.5.3.1 North Percolation Pond Area

4.5.3.1.1 Soil

For the North Percolation Pond Area, 17 inorganics (including metals and other inorganic parameters), 16 individual PAH compounds and both LMW and HMW PAH categories, 3 SVOCs, and 6 VOCs were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.1.2 Surface Water

For the North Percolation Pond Area, 17 inorganic constituents (including both total and dissolved fractions) and 8 PAHs were identified as refined COPECs in surface water. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.1.3 Sediment

For the North Percolation Pond Area, 15 inorganics (including metals and other inorganic parameters), 17 individual PAH compounds and Total PAHs, and 1 SVOC were identified as refined COPECs in sediment. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.2 South Percolation Pond Area

4.5.3.2.1 Soil

For the South Percolation Pond Area, 11 inorganics (including metals and other inorganic parameters), 2 individual PAH compounds and the HMW PAH category, 2 SVOCs, and 1 VOC were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.2.2 Surface Water

For the South Percolation Pond Area, 14 inorganic constituents (including both total and dissolved fractions) and 1 PAH were identified as refined COPECs in surface water. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.2.3 Sediment

For the South Percolation Pond Area, 10 inorganics (including metals and other inorganic parameters), 13 individual PAH compounds and Total PAHs, 2 SVOCs, and 2 VOCs were identified as refined COPECs in sediment. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.3 Cedar Creek Reservoir Overflow Ditch

4.5.3.3.1 Soil

For the Cedar Creek Reservoir Overflow Ditch Area, 10 inorganics (including metals and other inorganic parameters), 1 individual PAH compound and the HMW PAH category, and 3 SVOCs were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.3.2 Surface Water

For the Cedar Creek Reservoir Overflow Ditch Area, 7 inorganic constituents (including both total and dissolved fractions) were identified as refined COPECs in surface water. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.3.3 Sediment

For the Cedar Creek Reservoir Overflow Ditch Area, 7 inorganics (including metals and other inorganic parameters), 14 individual PAH compounds and Total PAHs, and 3 SVOCs were identified as refined COPECs in sediment. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.4 Northern Surface Water Feature

4.5.3.4.1 Soil

For the Northern Surface Water Feature Area, 8 inorganics (including metals and other inorganic parameters) and 1 SVOC were identified as refined COPECs in soil. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.4.2 Surface Water

For the Northern Surface Water Feature Area, 6 inorganic constituents (including both total and dissolved fractions) were identified as refined COPECs in surface water. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.3.4.3 Sediment

For the Northern Surface Water Feature Area, 8 inorganics (including metals and other inorganic parameters), 10 individual PAH compounds and Total PAHs, and 3 SVOCs were identified as refined COPECs in sediment. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.4 Aquatic Exposure Areas

4.5.4.1 Flathead River

4.5.4.1.1 Surface Water

For the Flathead River, 11 inorganic constituents (including both total and dissolved fractions) were identified as refined COPECs in surface water. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in Baseline Ecological Risk Analysis (**Section 5**).

4.5.4.1.2 Sediment

For the Flathead River, 4 inorganics (including metals and other inorganic parameters), 13 individual PAH compounds and Total PAHs, 2 SVOCs, and 3 VOCs were identified as refined COPECs in sediment. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.4.2 Cedar Creek

4.5.4.2.1 Surface Water

For Cedar Creek, 4 inorganic constituents (including both total and dissolved fractions) were identified as refined COPECs in surface water. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.4.2.2 Sediment

For Cedar Creek, 3 inorganics (including metals and other inorganic parameters), 12 individual PAH compounds and Total PAHs, and 2 SVOCs were identified as refined COPECs in sediment. These constituents were carried forward to the direct contact and (for bioaccumulative constituents) food ingestion risk characterization evaluation described in the Baseline Ecological Risk Analysis (**Section 5**).

4.5.5 Hot Spot Evaluation for Infrequently Detected Constituents

As described in **Section 4.4.3**, an additional evaluation was performed for constituents that were eliminated as refined COPECs because they were infrequently detected (less than 5 percent of samples) to ensure that localized areas with elevated constituent concentrations (i.e., “hot spots”) were not inappropriately dismissed at the COPEC refinement stage. Constituents eliminated due to low frequency of detection are presented in **Table 4-19** for exposure areas and media.

The maximum detected concentrations of constituents excluded due to the frequency of detection criterion were compared to a concentration equal to 10-times the greater of the BTV and ESV. Constituents with concentrations greater than this value were candidates for additional evaluation (i.e., plotting on a map to determine if localized clusters of samples with elevated concentrations are present). The only constituents that failed this initial hot spot criterion were PCBs in Main Plant Area soil and dissolved copper in Flathead River surface water (**Table 4-19**). Total PCBs in the Main Plant Area are comprised entirely of Aroclor 1254, which was eliminated from further evaluation in the hot spot evaluation because its maximum concentration of 0.11 mg/kg did not exceed 10-times the ESV of 0.041 mg/kg. Total PCBs were not similarly eliminated because the conservative ESV for total PCBs of 0.000332 mg/kg was carried over from the screening-COPEC evaluation to the COPEC refinement step due to a lack of alternate ESVs protective of Aroclor mixtures (**Table 4-19**). Therefore, no additional hotspot evaluation is necessary for PCBs. Dissolved copper was detected in only 2 out of 49 surface water samples in the Flathead River, and only the highest detected concentration (26 µg/L) exceeded a value equal to 10-times the BTV of 1.9 µg/L. Because only one sample with concentrations exceeding the initial hot spot criterion is present, this elevated concentration of dissolved copper is considered to be isolated, and no further evaluation or visualization of areas with high concentrations is necessary to determine if a hot spot is present in the Flathead River.

Several infrequently detected constituents across multiple exposure areas and media lack both a BTV and ESV (**Table 4-19**). Because there was no basis for their retention, these constituents were not subjected to further evaluation for hot spots. The lack of BTVs and ESVs results in a minor uncertainty for these constituents. However, all of these constituents except for 3- and 4-methylphenol were detected in a single sample. Therefore, a hot spot consisting of multiple samples with elevated concentrations could not be present for these constituents. One constituent lacking both a BTV and ESV, 3- and 4-methylphenol, was detected in Main Plant Area soil in 4 out of 120 samples with a maximum detected concentration of 0.036 mg/kg (**Table 4-19**). As a VOC, this constituent is not bioaccumulative. The low concentrations detected are not likely to impact communities of organisms in soil (i.e., plants and invertebrates), even if the detections were in a small spatial area. Therefore, this constituent was also not retained for further evaluation.

Based on the information presented above, it is highly unlikely that the elimination of constituents as refined COPECs based on low frequency of detection has eliminated any site-related constituents that may represent a hot spot where localized adverse effects to ecological receptors may occur. Therefore, none of the constituents listed in **Table 4-19** are retained as refined COPECs for additional evaluation in the BERA.

4.5.6 Refined COPEC Summary

The following sections present a summary of the refined COPECs identified by exposure medium.

4.5.6.1 Soil and Sediment

Refined COPECs identified in soil and sediment are summarized below by analytical group:

- Metals – Exceedances of refined ESVs were noted in multiple exposure areas and were most prevalent in the industrial areas (Main Plant Area, Central Landfills Area, Industrial Landfill Area, and the Incremental Soil Sample Grid).
- Cyanide – Exceedances were noted in all ecological exposure areas evaluated.
- Fluoride – Exceedances were noted in the industrial areas (Main Plant Area, Central Landfills Area, Industrial Landfill Area, and the Incremental Soil Sample Grid) as well as the North Percolation Pond Area.

- Dioxin and furan compounds – TEC concentrations exceeded soil concentrations protective of avian or mammalian exposure to 2,3,7,8-TCDD within the rectifier yards in the Main Plant Area, the Central Landfills Area, and the Western Undeveloped Area.
- PCBs – Exceedances were noted for Aroclor 1254 in the Central Landfills Area and in the Incremental Soil Sampling Grid.
- PAHs – Exceedances were primarily limited to the industrial areas (Main Plant Area, Central Landfills Area, Industrial Landfill Area, and the Incremental Soil Sample Grid), and North Percolation Pond Area. Other exposure areas where sediment was collected also had high numbers of PAHs carried forward for additional evaluation.
- Other SVOCs – Exceedances were noted in multiple exposure areas for several SVOCs, most commonly BEHP, benzaldehyde, carbazole, and di-n-butyl phthalate.
- VOCs were carried forward in many exposure areas. Cyclohexane, methyl acetate, methylcyclohexane, and xylenes were the most common VOCs carried forward for further evaluation.

4.5.6.2 Surface Water

Refined COPECs identified in surface water are summarized below by analytical group:

- Metals (dissolved) – Exceedances were noted for select metals, including aluminum for three of the four transitional exposure areas (North Percolation Pond, South Percolation Pond, and Flathead River Riparian Areas), barium (all aquatic and transitional exposure areas), cadmium (North Percolation Pond Area), and copper (North and South Percolation Ponds).
- Metals (total) – Aluminum, barium, beryllium, cadmium, copper, iron, lead, manganese, nickel, vanadium, and zinc all had concentrations in unfiltered surface water samples that exceeded criteria for the refined COPEC analysis. Barium (all transitional and aquatic exposure areas) followed by vanadium and aluminum (all transitional and aquatic exposure areas except Cedar Creek) had the most frequent exceedances.
- Cyanide – Exceedances for cyanide were observed in all transitional and aquatic exposure areas except the Northern Surface Water Feature.
- Fluoride – Exceedances were noted in only the North Percolation Pond Area.
- PAHs – PAH exceedances were either not observed or only sporadically observed in all transitional and aquatic exposure areas except the North Percolation Pond Area, which exceeded refined criteria for eight PAH constituents.
- SVOCs – The Flathead River Riparian Area had four SVOCs that exceeded criteria. The only other transitional or aquatic exposure area where SVOCs were selected as refined COPECs in surface water was the Flathead River (BEHP, which is a common laboratory contaminant and unlikely related to previous site activities).

4.6 COPEC Selection Uncertainty Analysis

Constituents were identified as COPECs in the initial screening-level COPEC selection process in multiple exposure media due to uncertainties in the screening-level exposure analysis. Constituents with uncertainties that result in some ambiguity as to whether they should be retained as COPECs are re-evaluated to assess whether the uncertainty associated with exposure to these constituents is likely to influence the overall findings and conclusions of the BERA. Constituents identified as COPECs in the BERA based on the following tiers of uncertainty were re-evaluated as part of the BERA problem formulation:

- Constituents below the detection limit with one-half of the MDL exceeding an ESV
- Detected constituents lacking ESVs

4.6.1 Constituents with MDLs Exceeding ESVs

To evaluate the potential importance of non-detected constituents with MDLs exceeding ESVs in the BERA, maximum MDLs were compared to the range of ESVs considered during COPEC selection in the COPEC screening evaluation. ESVs identified in the initial COPEC screening step were based on chronic, no effect endpoints used as ecological screening criteria by various agencies. While the minimum ESV from these sources was used in the initial conservative screening process, the range of ESVs based on chronic, no effect endpoints are considered to represent concentrations that are not likely to cause adverse ecological effects. Therefore, exposure to non-detected constituents, if present, with MDLs within the range of ESVs identified in the initial screening step is not likely to result in adverse ecological effects. Based on this rationale, non-detected constituents with MDLs below the maximum ESV identified in the screening-level evaluation are not likely to influence the overall findings and conclusions in the BERA.

An evaluation of MDLs was conducted to compare the MDLs achieved by the laboratory relative to the range of ESVs. The MDL evaluation is presented in **Tables 4-20**, **4-21**, and **4-22** for soil, sediment, and surface water, respectively. Each table presents minimum and maximum MDLs for constituents not detected in any site sample compared to minimum and maximum screening-level ESVs for each constituent.

Constituents in soil with MDLs exceeding the screening ESV also had at least one occurrence where the maximum MDL exceeded the maximum ESV (**Table 4-20**). Therefore, there is some concern that concentrations could be present in the soil at levels that are undetectable, but where adverse ecological impacts are possible. These constituents include 2 pesticides and 25 SVOCs. Pesticides have been previously determined to be of low concern at the Site. The SVOCs listed in **Table 4-20** are not known to be process related, and the fact that they were not present at detectable concentrations in over 700 soil samples reduces the level of concern regarding their possible presence. Furthermore, none are bioaccumulative constituents of concern that may significantly biomagnify in the food chain at very low concentrations. Therefore, these constituents are considered to be of low concern and are not considered further.

Similar to soil, several pesticides and SVOCs analyses in sediment samples resulted in MDLs that exceeded their sediment ESVs. Pesticides often have very low ESVs owing to their potential to biomagnify in the food chain. The ESVs are often back calculated from ingestion models with conservative assumptions and result in values that are below commonly achievable detection limits. As previously stated, however, pesticides are not considered to be site-related constituents of concern at the Site. Nineteen SVOCs and two VOCs also had MDLs that exceeded their ESVs. None of these constituents were detected in a single sediment (or soil, which was treated as sediment during wet exposure conditions in transitional exposure areas) sample. None of these constituents are known to be related to previous waste streams at the Site. SVOCs and VOCs are not typically considered bioaccumulative constituents that can biomagnify in food chains and result in toxicity for higher trophic order receptors even at very low concentrations in the target medium. Therefore, these constituents are considered to be of low concern and are not considered further.

For surface water, silver, eight pesticides, seven PCBs, one SVOC, and two VOCs had maximum MDLs that exceeded maximum ESVs (**Table 4-22**). There is minor uncertainty related to silver MDLs exceeding the range of silver ESVs for surface water. The range of detection limits for total and dissolved silver (1.3 to 1.5 µg/L) is within the range of available surface water ESVs (0.067 to 3.2 µg/L) that was used for the laboratory method sensitivity analysis presented in the Phase II Site Characterization Sampling and Analysis Plan (Roux, 2018a). The DEQ-7 acute water quality standard for silver is hardness-dependent; there is no promulgated DEQ-7 chronic water quality standard for silver (MDEQ, 2017). Based on hardness values measured in surface water samples at the Site ranging from 50 mg/L as $CaCO_3$ to 1,740 mg/L as $CaCO_3$, sample-specific DEQ-7 acute water quality standards for silver range from 1.23 to 552 µg/L. The maximum silver detection limit of 1.5 µg/L would be equivalent to the sample-specific acute water quality standard at a surface water hardness of 56 mg/L as $CaCO_3$. 278 of 279 surface water samples analyzed at the Site exceeded a hardness value of 56 mg/L as $CaCO_3$, indicating that the maximum detection limit is sufficient to detect silver concentrations at the promulgated MDEQ water quality standard in 278 of 279 surface water samples. Silver was also not known to be associated with a release at the CFAC facility and was not selected as a refined COPEC in any ecological exposure medium. Silver was not detected in surface water samples at the site and was infrequently detected in other exposure media evaluated in the BERA, indicating lack of association of silver with site-related migration pathways. Silver was detected in 1.2 percent of discrete soils samples (7 of 552) collected within the 0 to 2-feet soil interval and 1.2 percent of sediment samples (1 of 84) collected in the Phase I and II Site Characterization sampling events. (MDLs for soil and sediment did not exceed minimum ESVs for silver.) Therefore, the fact that surface water MDLs for silver are slightly above the conservative screening value presented in **Table 4-22** is acknowledged as a minor uncertainty, but the level of concern is not considered sufficient to retain silver as a COPEC in surface water.

The SVOCs and VOCs listed in **Table 4-22** are not known to be process related, and the fact that they were not present at detectable concentrations in 17 to 23 surface water samples reduces the level of concern regarding their possible presence. Furthermore, none are bioaccumulative constituents of concern that may significantly biomagnify in the food chain at very low concentrations. Therefore, these constituents are considered to be of low concern and are not considered further. Pesticides have been previously determined to be of low concern at the Site, but PCBs have been detected in portions of the Site that were formerly used for industrial processes. However, both PCBs and pesticides are strongly hydrophobic, and are unlikely to partition to surface water in appreciable amounts compared to the concentrations in sediment. Furthermore, any potential risk associated with them would be more effectively handled by addressing sediment, which would represent the source for any trace amounts of these constituents in surface water. Therefore, these constituents are considered to be of low concern and are not considered further.

4.6.2 Constituents Lacking ESVs

Constituents evaluated for COPEC refinement that lacked ESVs are presented in **Tables 4-23, 4-24,** and **4-25** for soil, sediment, and surface water, respectively. The range of BTVs across all applicable reference areas is also provided in these tables for additional information. Three SVOCs and 6 VOCs in soil lacked ESVs and could not be retained or eliminated based on comparisons to benchmark values associated with acceptable levels of ecological risk (**Table 4-23**). The three SVOCs were all detected at less than 15 percent detection frequency, with concentrations at or below 1 mg/kg. Maximum detected concentrations slightly exceeded the BTV for the two constituents for which BTVs were available. The VOCs were detected more frequently in soil (22 to 57 percent detection frequency); however, detected concentrations were all below 1 mg/kg. VOCs tend to be short-lived in soil, volatilizing to the air or naturally breaking down due to the actions of bacteria and microbes in the soil. Further, neither the SVOCs nor VOCs on this list are expected to be bioaccumulative constituents that could pose potential risks via food chain effects. Furthermore, if retained as COPECs, few if any toxicity data are available that would allow an estimation of potential effects on ecological receptors. For these reasons, the presence of these 9 constituents in Site soil is considered a minor uncertainty that is highly unlikely to affect conclusions based on constituents for which ESVs are available.

For sediment, four metals, three SVOCs, and three VOCs were detected but lacked ESVs (**Table 4-24**). Although the four metals (barium, beryllium, thallium, and vanadium) lack ESVs based on sediment exposure, ESVs are available for them based on soil exposure. Thus, they were evaluated in the terrestrial scenario for transitional exposure areas. NOEC and LOEC data are available for potential impacts to benthic invertebrates for barium. However, little additional data are available for the other three metals to evaluate their potential toxicity in aquatic sediment. Mean and maximum detected concentrations for the four metals exceeded the maximum BTV in reference areas used to establish soil background concentrations. For the three SVOCs and three VOCs that lacked ESVs, all were detected at relatively low concentrations, with the exception of carbazole, which was detected at a maximum concentration of 190 mg/kg. Carbazole is an aromatic heterocyclic compound that is strongly associated with the presence of PAHs, and it is likely that any further activities to evaluate PAHs will also address carbazole. Although the three SVOCs had maximum concentrations that exceeded BTVs (BTVs were not available for the three VOCs), the remaining organic constituents are not known or suspected to be site-related and are not expected to pose a threat to ecological receptors through food chain effects (bioaccumulation). Therefore, the presence of these constituent in site sediment is considered a minor uncertainty that is highly unlikely to affect conclusions based on constituents for which ESVs are available.

Vanadium (unfiltered) and four SVOCs were detected but lack ESVs in surface water (**Table 4-25**). Vanadium was present at concentrations greater than its BTV. Although an ESV protective of total (unfiltered) concentrations of vanadium in surface water was not identified in the sources used for obtaining benchmarks used in the refined COPEC analysis, NOEC and LOEC values for total vanadium of 19 and 190 µg/L, respectively, were identified in LANL ECORISK (2017), and were used to evaluate total vanadium effects for direct toxicity (see **Table 5-5**). Therefore, a robust evaluation of this metal was performed in the BERA in spite of the lack of an ESV for the dissolved fraction. The four SVOCs that lacked ESVs were only detected in one or two surface water samples. BTVs were available for three of the SVOCs, and two (benzaldehyde and carbazole) were detected at maximum concentrations that exceeded their BTVs. All detected concentrations were below 10 µg/L, and none are known to be site-related or are suspected to be a threat to wildlife receptors via their bioaccumulation potential. Therefore, the presence of these constituents in site surface water is considered a minor uncertainty that is highly unlikely to affect conclusions based on constituents for which ESVs are available.

5 Baseline Ecological Risk Analysis

The following sections present the framework for the baseline risk analysis developed based on data and observational information generated as part of the Phase I and Phase II Site Characterization and integrated in the BERA Problem Formulation (**Section 3**). The Problem Formulation provides the basis for the selection of assessment endpoints, risk questions, and measurement endpoints for assessment in the BERA. Exposure estimates are developed for the identified assessment and measurement endpoints based on quantitative comparisons of EPCs derived as part of the exposure analysis to effects endpoints established based on the ecological effects analysis.

5.1 Assessment Endpoints, Risk Questions, and Measurement Endpoints

Assessment endpoints are identified to explicitly express the environmental value that is to be protected (USEPA, 1997). Measurement endpoints are qualitative or quantitative observations that are measured for each receptor category in each exposure area to evaluate the assessment endpoint. Risk questions were formulated to identify specific measurable ecological characteristics that could be used to evaluate the selected assessment endpoints. These measurement endpoints represent numerical observations that will be measured in ecological exposure areas and compared to similar observations measured at reference sites or reported in the literature (e.g., effects thresholds). The selected measurement endpoints are used in a weight-of-evidence assessment of risk to each representative receptor based on the identified assessment endpoints.

Based on the problem formulation and ECSMs presented in **Section 3**, assessment endpoints, risk questions, and measurement endpoints were formulated for terrestrial, transitional, and aquatic exposure areas identified in **Section 3.3.1** (**Figures 3-2** through **3-4**, respectively). A summary of the risk questions and measurement endpoints selected for each assessment endpoint is provided in **Table 5-1** for terrestrial exposure areas, **Table 5-2** for transitional exposure areas, and **Table 5-3** for aquatic exposure areas.

Assessment endpoints include potential exposure to special status species (Threatened or proposed Threatened) that were identified by the USFWS IPaC query (**Section 3.3.5**). Consistent with ERAGS, potential exposure to Threatened species is evaluated based on the individual level of organization, as opposed to population level (**Table 5-1** to **Table 5-3**). Measurement endpoints for Threatened species is based on comparisons of estimated daily doses to NOAEL TRVs. Further evaluation of the assessment endpoints for special status species is conducted as part of the BERA Problem Formulation. Additional considerations for these assessment endpoints include an assessment of the potential for special status species to occur in site exposure areas based on documented occurrences and the potential for suitable habitat to support the special status species. The following section presents the risk analysis approach used to support the evaluation of measurement endpoints in the BERA.

5.2 Effects Analysis

As part of the risk analysis phase, the ecotoxicity review presented in the BERA Problem Formulation (**Section 3.3.7**) was used as the basis to identify receptor-specific benchmarks to estimate the potential ecotoxicological effects of primary COPECs relevant receptor groups within terrestrial, transitional, and aquatic exposure areas at the Site. The following sections describe the basis of developing receptor-specific effects endpoints for the baseline risk analysis phase.

5.2.1 Direct Contact Exposure Pathways

The effects analysis for direct contact pathways was conducted based on literature and guidance reviews to refine direct contact ESVs to represent receptor-specific exposure. Two general tiers of endpoints were identified, as available, to evaluate the potential for adverse effects related to direct contact exposure pathways:

- NOEC: Representative of the central tendency (e.g., geometric mean) of NOEC endpoints identified for relevant test organisms in literature/database studies.
- LOEC: Representative of the low end of the distribution of LOEC endpoints (e.g., 15th percentile or bounded study endpoints) identified for relevant test organisms in literature/database studies.

When available, existing estimates of NOECs and LOECs derived in the literature or guidance based on the geometric mean of no effect endpoints was used in the BERA. If insufficient data were available to establish geometric means, established NOECs and LOECs from literature or guidance were used instead. NOEC and LOEC endpoints for direct contact pathways are presented in **Tables 5-1** through **5-3**. The following sections describe the general approach for conducting effects analyses for direct contact exposure pathways from relevant exposure media.

5.2.1.1 Soil

Potential effects associated with direct contact pathways from soils were evaluated based on literature and database reviews of NOEC and LOEC endpoints from toxicological studies. Effects endpoints were established for the receptor categories identified for direct contact pathways to soil in the terrestrial and transitional ECSMs and measurement endpoints for soil (**Table 5-4**):

- Terrestrial plant community
- Soil invertebrate community

Sources of toxicological data that were used to support the development of direct contact NOEC and LOEC endpoints for soil COPECs include:

- USEPA Eco-SSLs
- Oak Ridge National Laboratory (ORNL) Risk Assessment Information System (RAIS)
- LANL ECORISK Database
- USEPA ECOTOX Database
- Targeted literature reviews for specific COPECs and receptor categories

5.2.1.2 Surface Water

Potential effects associated with direct contact pathways from surface water were evaluated based on literature/database reviews of survival, growth, and reproduction endpoints from aqueous toxicity studies. When available, USEPA and MDEQ promulgated chronic and acute surface water quality criteria were used as the basis for NOEC and LOEC endpoints, respectively for the protection of aquatic receptors that may be exposed to surface water in aquatic and transitional exposure areas at the Site. Effects endpoints were established for the receptor categories identified for direct contact pathways to surface water in aquatic and transitional ECSMs and measurement endpoints for surface water (**Table 5-5**):

- Aquatic plant community

- Benthic and pelagic invertebrate community
- Fish and herptiles (amphibians and reptiles)

Receptor-specific surface water NOEC and LOEC endpoints were derived from a review of aqueous toxicity studies and databases for relevant test organisms to support the evaluation of measurement endpoints (**Table 5-5**). Sources of aqueous toxicity studies to support the derivation of receptor-specific surface water benchmarks include:

- USEPA NRWQC (USEPA, 2019)
- MDEQ Circular DEQ-7 (MDEQ, 2017)
- USEPA ECOTOX Database
- LANL ECORISK Database
- ORNL RAIS
- Targeted literature reviews for specific COPECs and receptor categories

Where applicable, effects endpoints that consider site-specific conditions that influence COPEC bioavailability and toxicity in surface water were preferentially selected. When available, USEPA or MDEQ promulgated chronic and acute surface water quality criteria were used as the basis for NOEC and LOEC endpoints, respectively. For metals, NOECs and LOECs were based on the phase used as the basis for surface water quality criteria. USEPA NRWQC for several metals are based on exposure to the dissolved phase, with criteria for some metals (cadmium, chromium, lead, nickel, zinc) calculated as a function of surface water hardness (as mg/L $CaCO_3$). For these metals, NOECs and LOECs were based on sample-specific hardness measurements to spatially and temporally align hardness and filtered (dissolved) metals results. For copper, NOEC and LOEC concentrations were based on the BLM, consistent with the USEPA NRWQC. In addition, recently promulgated USEPA aquatic life ambient water quality criteria for aluminum that considers the influence of hardness and pH on aluminum toxicity were used to establish NOECs and LOECs for total (unfiltered) aluminum (USEPA, 2018). MDEQ water quality criteria (chronic and acute) are based on the total (unfiltered) phase for all metals, except for aluminum. In addition to differences in surface water quality criteria for metals, USEPA evaluates aqueous cyanide exposure based on analyses of free cyanide and MDEQ evaluates cyanide exposure on the basis of total cyanide. Given the differences in the basis of surface water quality criteria for metals and cyanide between USEPA and MDEQ, effects endpoints were established and evaluated based on dissolved and total phase results for metals and free and total cyanide results.

Sources of aqueous toxicity data included sources identified for surface water, but also included final chronic values (FCVs) presented in the ESB guidance for PAH exposure in pore water (USEPA, 2003a). FCVs are considered to be protective of aquatic species in the derivation of ESBs; therefore, the FCVs are considered appropriate for direct comparisons to aquatic receptors that may be exposed to surface water.

Surface water exposure pathways for COPECs and receptor categories lacking available aqueous toxicity endpoints are addressed as an uncertainty in the BERA (**Section 7**).

5.2.1.3 Sediment

Direct contact effects associated with exposure to sediment were evaluated based on benthic invertebrate effects endpoints. When available, potential effects associated with direct contact pathways from sediment to benthic invertebrates were evaluated based on predictive models derived using EqP relationships. The approach for deriving ESBs was based on USEPA ESB guidance for multiple constituent groups relevant to sediment exposure in aquatic and transitional exposure areas at the Site:

- PAHs: *USEPA Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: PAH Mixtures* (USEPA, 2003a)
- Divalent metals: *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Metals Mixtures (Cadmium, Copper, Lead, Nickel, Silver, and Zinc)* (USEPA, 2005a)
- Nonionic Organic Compounds: *Procedures for the Derivation of Equilibrium Partitioning Sediment Benchmarks (ESBs) for the Protection of Benthic Organisms: Compendium of Tier 2 Values for Nonionic Organics* (USEPA, 2008a)

For organic COPECs lacking ESB values from the above sources, site-specific ESBs were derived using the sample-specific fraction of organic carbon (f_{oc}), constituent-specific organic carbon-water partitioning coefficient (K_{oc}), and WQB based on the EqP presented in **Section 4.4.1**.

In the absence of appropriate EqP relationships to derive site-specific ESBs for COPECs, literature and database reviews were conducted to identify NOEC and LOEC endpoints from toxicological studies. Sources of toxicological data that were used to support the development of direct contact NOEC and LOEC endpoints for sediment COPECs include (**Table 5-6**):

- National Oceanic and Atmospheric Agency (NOAA) Sediment Toxicity (SEDTOX) Database
- ORNL RAIS
- LANL ECORISK Database
- Targeted literature reviews for specific COPECs

5.2.1.4 Pore Water

Potential effects associated with direct contact pathways to pore water were evaluated based on literature and database reviews of survival, growth, and reproduction endpoints from aqueous toxicity studies. When available, pore water NOEC and LOEC benchmarks were derived for each receptor category that may be exposed to pore water in the ECSM (aquatic plants, benthic invertebrates, amphibians) using aqueous toxicity endpoints for test organisms representing each receptor category. Sources of aqueous toxicity data included sources identified for surface water, but also included FCVs presented in the ESB guidance for sediment (USEPA, 2003a). FCVs are considered to be protective of aquatic species in the derivation of ESBs; therefore, the FCVs are considered appropriate for direct comparisons to pore water to evaluate potential effects to benthic invertebrates. WQBs derived for the protection of general aquatic life are considered protective of all receptor categories that may be exposed to pore water.

Consistent with the derivation of surface water effect endpoints, the derivation of pore water effects endpoints considered site-specific conditions that influence COPEC bioavailability and toxicity. Site-specific conditions in pore water that were considered in the development of effects endpoints included:

- Pore water pH: Influences the bioavailability and toxicity of cyanide, aluminum, and other metals.
- Pore water hardness: Criteria for the dissolved phase of select metals is a function of pore water hardness (as $CaCO_3$).

- Free cyanide: Represents the bioavailable and potentially toxic form of cyanide. Toxicity studies based on free and total cyanide were included for evaluation, consistent with USEPA NRWQC (which are based on free cyanide) and DEQ-7 values (which are based on total cyanide).

In the absence of available aqueous toxicity endpoints for specific receptor categories, chronic surface water quality criteria for the protection of aquatic life promulgated by the USEPA NRWQC or MDEQ were considered default NOECs for the protection of receptors that may be exposed to pore water.

5.2.2 Ingestion Exposure Pathways

For ingestion pathways, the effects analysis included a detailed review of TRVs derived from toxicological studies to evaluate the potential for adverse ecological effects associated with the dietary doses estimated using the approaches described in **Section 5.3.3**. Two tiers of chronic TRVs representing NOAELs and LOAELs for growth, reproduction, and survival endpoints were identified to evaluate the potential for adverse effects via ingestion pathways:

- Low, NOAEL-based TRV (TRV_{NOAEL}): Represents the geometric mean NOAEL TRV identified in literature studies.
- High, LOAEL-based TRV (TRV_{LOAEL}): Represents a TRV based on chronic exposure, that estimates a geometric mean LOAEL in literature studies.

The two tiers of TRVs were used to evaluate potential wildlife exposure based on estimated daily doses (EDDs) calculated using screening-level. TRVs were obtained primarily from peer-reviewed compilations of toxicity data for ecological risk assessment from sources including, but not limited to:

- USEPA Eco-SSLs
- ORNL *Toxicological Benchmarks for Wildlife*: 1996 Revision (Sample et al., 1996)
- LANL ECORISK Database
- Targeted literature reviews for specific COPECs and receptor categories

In addition, at the request of USEPA, LOAELs provided in TechLaw (2008) and the approach for deriving TRVs presented in that document were also considered in the selection of TRVs. TRVs presented in *Development of Toxicity Reference Values for Conducting Ecological Risk Assessment at Naval Facilities in California, Interim Final* (Engineering Field Activity West, 1998) were also considered as a source for toxicity reference values. The TRVs selected for use in the BERA, and the basis for deriving TRVs from literature and database searches was presented in an interim deliverable to the BERA Work Plan, which is included in **Appendix A2**.

5.3 Exposure Analysis

Risk estimates were developed in the BERA using data and observational information generated as part of the Phase I and Phase II Site Characterization. Risk estimates were based on quantitative comparisons of EPCs to effects thresholds established based on the refined ecological effects analysis discussed in the preceding section. EPCs for mobile receptors were based initially on maximum concentrations, and refined assumptions were used to develop conservative estimates of average concentrations that receptors could be exposed to during their foraging activities. EPCs for risk estimation via direct contact and ingestion pathways were calculated based on UCL_{mean} COPEC concentrations to represent a conservative estimate of average exposure conditions over an exposure area.

5.3.1 Calculation of Exposure Point Concentrations

EPCs to evaluate exposure in the BERA were estimated for each exposure area using data collected as part of the Phase I and Phase II Site Characterizations. EPCs were calculated to represent a range of exposure scenarios:

- Maximum EPC: Represent a reasonable maximum exposure scenario based on the maximum measured concentration in each exposure area.
- Refined EPC: Represent likely exposure scenarios based on random exposure throughout each exposure area.

Refined EPCs for risk estimation via direct contact and ingestion pathways were calculated based on UCL_{mean} COPEC concentrations to represent average exposure conditions over an exposure area. UCL_{mean} concentrations were calculated using USEPA ProUCL software (version 5.1 or later) and the statistical approach described in the USEPA ProUCL Version 5.1 Technical Guidance (USEPA, 2015b). Although 95 percent UCLs were the target values to use as the refined EPCs, the term "UCL_{mean}" is used in this report because, at times, UCL values other than the 95 percent UCLs were selected as EPCs based on ProUCL outputs. In general, the 95 percent UCLs recommended in ProUCL were used as the refined EPC in the risk estimate. When the UCL recommended by the ProUCL software exceeded the maximum detected concentration, the most conservative UCL derived using the Chebyshev method that produced a result lower than the maximum was selected as the UCL_{mean} and adopted as the refined EPC. ProUCL input and output data are presented in **Appendix I**. All UCLs selected as EPCs had a confidence limit of 95 percent or greater, except for three UCL_{mean} values that had confidence limits of 90 percent. A summary of the types of UCLs selected as the refined EPCs by media is presented in the following table:

Type of Upper Confidence Limit (UCL) of the Mean	Soil/Sediment UCLs	Soil UCLs	Surface Water UCLs
90% UCLs	2	1	0
95% UCLs	483	265	77
97.5% UCLs	13	0	2
99% UCLs	4	0	2
Other (e.g., Gamma-adjusted Kaplan-Meier UCL)	28	9	8

In addition to UCL_{mean} EPCs, exposure was also evaluated on a point-by-point basis for sedentary receptors, such as plants, soil invertebrates, and benthic invertebrates, and wildlife receptors with small home ranges (e.g., meadow vole, short-tailed shrew). The evaluation of potential exposure on a point-by-point basis supports a spatial evaluation where sedentary or small home range receptors may be exposed to localized concentrations in soil that may result in adverse effects. Further discussion of the approach for evaluation exposure to small home range wildlife receptors is presented in **Section 5.3.3.2.2**.

EPCs were developed in the Operational Area for individual ISS DUs for the purpose of evaluating potential risk to sessile or small range receptors that would receive 100 percent of their exposure within a given DU; ISS data collected within the Operational Area were not evaluated for exposure to large-range receptors. The Operational Area where the ISS sample grids are located represents a sub-area that overlaps two ecological exposure areas, specifically the Central Landfill Area and the Main Plant

Area. ISS samples were only collected in a sub-area of the facility where the locations of specific source areas and migration pathways were not known. ISS results (i.e., the concentrations resulting from the single replicate adjusted for the variance within the DUs with triplicate samples or the UCL_{mean} calculation performed on these DUs with replicates) were evaluated for each grid based on point-by-point comparisons with ecological benchmarks to evaluate soil exposure to plants, soil invertebrates, and wildlife receptors with foraging ranges less than the size (approximately 1 acre) of the ISS DUs. Because the home ranges for these receptors are approximately equal to or smaller than the size of the DUs, no adjustment for spatial use (e.g., and AUF) was used to adjust the DU EPC. ISS triplicate UCL_{mean} calculations and the DU-adjusted concentrations are presented in **Appendix J**. For the four DUs with triplicate incremental samples, UCL_{mean} values were calculated for constituents that were detected in at least one of the three incremental samples using the ITRC calculator as described in **Section 4.1.1.1**. One-half the method detection limit was used as the surrogate values for non-detects (ITRC, 2012a and 2012b). $UCLs_{mean}$ calculated using only three results will always be greater than the maximum detected concentrations; therefore, the UCL generated by the ITRC UCL calculator was always selected as the EPC for the ISS triplicate sample results. EPCs for DUs where only a single incremental sample was collected were adjusted based on the variance observed for each constituent in each soil depth interval, as reflected by the average RSD for that constituent across the four DUs where triplicate samples were collected. The equation showing this adjustment is presented in **Section 4.1.1.1**.

As part of the broader, facility-wide investigation, discrete soil samples were also collected within the ISS sampling grid footprint during Phase I and Phase II Site Characterization. Data from these discrete samples were evaluated separately from the ISS evaluation; due to different underlying statistical properties, it is not appropriate to combine data derived from ISS and discrete samples to calculate statistical parameters that reflect an overall exposure to the area (e.g., UCL_{mean} EPCs for large-range receptors). Discrete samples were collected (including within the Operational Area) to fully characterize potential risk to ecological receptors across the entire Site. Therefore, data from discrete samples that were located within the ISS grids were evaluated in a manner consistent with other discrete soil samples, i.e., they were evaluated on a point-by-point basis for comparison to benchmarks protective of small-range and sessile receptors, and they were included in the larger exposure area dataset for evaluation of the protection of larger ranging receptors. A discussion of the differences in concentrations between the discrete and ISS soil samples collected within the Operational Area is presented in the Uncertainty Analysis (**Section 7.12**).

5.3.2 Direct Contact Exposure Pathways

Direct contact exposure pathways identified in the ECSM were evaluated based on comparisons of EPCs to receptor-specific effects endpoints (**Section 5.2.1**). As stated in the preceding section, direct contact exposure evaluations included a range of exposure conditions based on maximum EPC and refined EPC scenarios. Maximum and refined EPCs were compared to NOEC and LOEC endpoints to evaluate the potential for adverse effects based on a range of effects endpoints.

5.3.3 Ingestion Pathways

The evaluation of potential exposure via direct and incidental ingestion pathways was conducted based on a tiered approach in accordance with the USEPA guidance for conducting probabilistic ecological risk assessment (USEPA, 2001b). The tiered approach utilizes deterministic and then, if necessary, probabilistic exposure modeling if additional analysis is warranted (e.g., if deterministic modeling exceeds doses associated with LOAELs). Deterministic exposure modeling is based on conventional single point estimates of EPCs and typical exposure parameters, while probabilistic exposure modeling estimates exposure based on the distributions of EPCs and exposure parameters to account for variability and/or uncertainty in model parameters. The results of the deterministic model were reviewed, and although LOAEL-based exceedances were observed, it was determined that additional information obtained through probabilistic modeling would not materially affect conclusions or provide additional insight into recommendations or conclusions. Therefore, probabilistic modeling was not performed in this BERA.

Wildlife receptors identified in **Section 3.3.6** as being representative of the foraging guilds present at the Site were evaluated for potential food chain effects resulting from ingestion of prey items exposed to contamination in Site media. Life history characteristics affecting parameters that are critical for estimating exposure (e.g., body weight, ingestion rate) are presented in the wildlife modeling interim deliverable in **Appendix A2**. Also presented in that interim deliverable are the various uptake models used to estimate concentrations in prey or food items, TRVs that reflect NOAELs and LOAELs, complete descriptions of the ingestion and dose modeling equations, and other supporting information necessary to interpret the results of the ingestion modeling.

5.3.3.1 Model Structure

Dietary exposure estimates consider the typical dietary preference and composition for each receptor, in terms of representative dietary items at the site. Exposure estimates for ingestion pathways were based on comparisons of receptor-specific EDDs calculated from simple dose rate models to TRVs. The general form of the dose rate model used to calculate EDDs in both modeling scenarios is as follows:

$$EDD = \frac{1}{BW}\sum_{i=1}^{N}\left(FIR_{dw} \times \sum_{j=1}^{M}(f_j \times C_j) + SIR \times C_{sub} + WIR \times C_{sw}\right)_i \times AUF_i$$

where:

- i = Number of exposure areas
- j = Receptor-specific dietary items
- BW = Receptor-specific body weight
- FIR_{dw} = Receptor-specific daily food ingestion rate (dry weight)
- f_j = Proportion of dietary item *j* to total dietary composition
- C_j = COPEC concentration in dietary item *j*
- SIR = Receptor-specific incidental sediment ingestion rate
- C_{sub} = COPEC concentration in substrate (sediment or soil)
- WIR = Receptor-specific daily drinking-water ingestion rate
- C_{sw} = COPEC concentration in unfiltered surface water
- AUF_i = Area use factor

It should be noted that dietary exposure to fish was not evaluated for transitional areas, as these areas do not sustain an aquatic environment capable of supporting fish populations to provide a sufficient forage base for piscivorous wildlife.

A modified version of the model was used to evaluate the potential additive exposure to dioxin and furan compounds in surface soil sampled within the Main Plant Area and adjacent areas. The modified dietary exposure model calculated an EDD for the 17 individual dioxin and furan compounds in each sample based on measured concentrations and soil-to-biota bioaccumulation factors (BAFs). The EDD for each compound was multiplied by the compound-specific TEF for birds or mammals to estimate the TEC for each compound (Van den Berg et al., 2006; Van den Berg et al., 1998; USEPA, 2008b). TECs of the 17 dioxin and furan compounds in each sample were summed to calculate an overall TEC for the sample. Thus, the EDD was calculated for each dioxin/furan congener as described in the above equation, multiplied by the congener-specific (bird or mammal) TEF, and then summed with the other congener EDDs to calculate the TEC. The TEC for each sample was evaluated relative to avian or mammalian dietary TRVs for 2,3,7,8-TCDD.

5.3.3.2 Modeled Scenarios

A screening-level and refined food chain model was performed for the Site. The screening-level model used maximum exposure concentrations and did not use an area use factor (AUF) to estimate risk to large-range receptors. The refined food chain model used a conservative estimate of the mean (i.e., UCL_{mean} concentrations) as the exposure concentrations, and incorporated AUFs to adjust risk for receptors that have home ranges that are larger than the exposure area being evaluated.

In addition to the screening-level and refined model scenarios, additional scenarios were evaluated for: 1) large home range wildlife receptors that may forage in multiple exposure areas throughout the site and 2) small home range receptors that may forage entirely within a small portion of an exposure area. A description of the modeled scenarios for large and small home range receptors is provide below.

5.3.3.2.1 Large Home Range Receptors – Spatially Weighted Exposure Evaluation

As described in **Appendix A2**, large home range receptors that may receive exposure from adjacent (non-target) exposure areas as well as the target exposure area were evaluated using a spatially weighted approach in the refined model. Essentially, an AUF-adjusted dose for each constituent was calculated based on the percentage of the particular receptor home range that is comprised of the target exposure area as well as all adjacent exposure areas that fell within the home range (assuming the receptor was placed in the geographic center of the target exposure area). Areas outside of the Site boundary that fell within a receptor home range were included in the spatial weighting and assigned a dose of zero. Depending on the overlapping footprints of an assumed circular home range with an irregularly shaped exposure area boundary, this approach occasionally resulted in doses from adjacent exposure areas strongly influencing the exposure estimates, particularly for receptors with small to moderately sized home ranges that may forage entirely within a single exposure area. At the request of USEPA, an AUF of 1 was applied for receptors whose home range was less than the size of the exposure area; the entire dose for that receptor was assumed to originate within the target exposure area.

Area-weighted doses from exposure areas within the potential foraging range of receptors were summed to estimate the total aggregate dose for that receptor. Constituents with HQs below 1 for any given exposure area were assumed to have negligible contribution to adjacent exposure areas for that constituent. The percentages of various exposure areas that fall within large-range receptor home ranges are presented in **Table 5-7**. The "target" exposure area being evaluated is presented vertically in the second column, and the areas to which the receptor is exposed to (given a circular home range originating within the geometric centroid of each target exposure area) are presented horizontally, with the percentage of exposure for each presented in the table. For example, the American woodcock with a home range of 11.1 acres, evaluated for the South Percolation Pond Area, receives 22.4 percent of its modeled dose from the South Percolation Pond Area, 0.4 percent from the Main Plant Area, 69.6 percent from the Flathead River Riparian Area, and 7.6 percent from unimpacted areas outside the Site boundary. This spatial weighting was only performed for terrestrial receptors that may forage randomly between terrestrial and transitional exposure areas. Although many species that forage on fish and benthic invertebrates are likely to utilize multiple water bodies during their daily activities, aquatic receptors (i.e., the American dipper, belted kingfisher, and mink) were assumed to receive 100 percent of their exposure to media within the transitional or aquatic exposure area evaluated.

5.3.3.2.2 Small Home Range Receptors – Point-by-Point Exposure Evaluation

A point-by-point evaluation of soil sample results was performed to evaluate the potential for adverse effects to small range receptors that may be exposed to COPECs in foraging ranges smaller in spatial scale than the ecological exposure areas that were used to evaluate medium- and large-range receptors. The life-history characteristics of the wildlife receptors of concern were reviewed, and the meadow vole (home range = 1 acre) and the short-tailed shrew (home range = 0.13 acre) (Table 2 in the wildlife modeling interim deliverable for the BERA Work Plan presented in **Appendix A2**) were selected as the small range receptors of concern for this evaluation.

Consistent with the approach used to calculate USEPA Eco-SSL values (USEPA, 2005b), the general exposure model presented in **Section 5.3.3.1** was used to back-calculate soil benchmark concentrations from TRVs using the *Goal Seek* function in Microsoft Excel. Back-calculated soil benchmarks for each representative small home range receptor were calculated by setting the EDD equivalent to the TRV and solving for the concentration in soil or sediment (C_{soil}). Soil benchmarks were calculated based on

TRV_{NOAEL} and TRV_{LOAEL} values (**Section 5.2.2**). TRV_{NOAEL} and TRVLOAEL -based soil benchmarks were compared on a point-by-point basis to soil data from discrete samples, as well as the individual ISS DU results from the Operational Area (see **Section 5.3.1** for a description of DU EPC calculations) from the relevant exposure intervals. Comparisons of TRVNOAEL and TRVLOAEL -based benchmarks to soil data from relevant exposure intervals are presented visually within each exposure area to illustrate potential station-specific risks to small home range receptors. Soil benchmarks protective of small range-receptors are presented in **Table 5-8**. The full description of the small range receptor evaluation—including maps indicating where exceedances occurred—is presented in **Section 6**.

5.3.3.3 Exposure Point Concentrations

EPCs for soil, sediment, or surface water inputs into screening-level exposure models were initially based on the maximum measured concentration in each exposure medium to represent the most conservative exposure scenario. A refined version of the model was run using EPCs that reflected a conservative estimate of the central tendency of exposure (e.g., UCL_{mean} concentration) to estimate the average dose that a receptor may experience while foraging randomly within an exposure area.

As described in the wildlife modeling interim deliverable to the BERA Work Plan presented in **Appendix A2**, most receptors were assumed to be exposed primarily to soil in only the shallow (0 to 0.5 foot) sampling interval. For receptors whose life history patterns indicate the potential for regular exposure to deeper soil (e.g., the short-tailed shrew, meadow vole, long-tailed weasel, and North American wolverine; note that the shrew was not included as a receptor that would likely encounter deeper soil in the BERA wildlife modeling interim deliverable presented in **Appendix A2**, however, after reviewing its foraging patterns, it is included as a burrowing receptor in the BERA), dietary ingestion pathways associated with soils were based on depth-weighted average concentrations of sampling intervals collected from 0 to 0.5 ft-bgs and 0.5 to 2.0 ft-bgs to provide a representative EPC for each soil boring station. Depth-weighted average concentrations for the 0 to 2 ft-bgs sampling interval were calculated as follows:

$$C_{sub,0-2ft} = C_{sub,0-0.5ft} \times \frac{0.5ft}{2ft} + C_{sub,0.5-2ft} \times \frac{1.5ft}{2ft}$$

where:

$C_{sub,x\text{-}y\ ft}$ = Concentration in sampling interval starting from *x* to *y* ft-bgs.

In some cases, data were only available for one interval but not both. In these cases, it was assumed that the concentration present in the sampled depth interval represented the concentration present in the entire 0 to 2 feet depth range. Most commonly, a 0 to 0.5-foot sample was collected, but not a 0.5 to 2 feet sample, rather than the reverse scenario. As described in **Section 3.6** and **Section 4.1.1**, an evaluation of the Phase I and Phase II Site Characterization data indicated that COPEC concentrations are generally greater in surface and shallow intervals and decrease with increasing soil depth (EHS Support, 2018 and 2019). Therefore, the use of data from the only interval sampled when data from both soil depth intervals were not available likely results in a conservative EPC for soil.

For surface water in the screening-level food chain models, the maximum detected concentration for each COPEC across all exposure areas was selected as the EPC for the source of drinking water for terrestrial exposure areas. Thus, it was assumed that ecological receptors would drink exclusively from the surface water bodies at the Site with greatest exposure to surface water COPECs. This is a conservative assumption; receptors with large home ranges would ingest drinking water from multiple sources, and the origin of the water body where the maximum concentration was detected may be well outside the home range for small range receptors in terrestrial exposure areas. For transitional and aquatic exposure areas, the maximum concentrations detected from the water bodies located within each exposure area was used as the exposure concentration.

For the refined version of the wildlife ingestion models, the $UCL_{mean,}$ concentration (or the average concentration, using the quantitation limit as a surrogate for non-detected results if a constituent had too few detections to calculate a UCL) from the surface water body present at transitional and aquatic exposure areas was used as the EPC. For receptors in terrestrial exposure areas, the UCL_{mean} of the sitewide surface water dataset was calculated and used as the EPC for drinking water exposure. No adjustment was included to account for the fact that different numbers of samples were collected from the various water bodies; however, the water bodies with the larger number of samples were also larger in area and/or had the greatest probability of being used as drinking water sources. Therefore, any bias in the estimation of surface water EPCs associated with the unequal sampling design between the water bodies is considered a minor uncertainty in the BERA.

The approach to estimating drinking water EPCs deviates slightly from the BERA Work Plan and *Technical Memorandum: Proposed Wildlife Exposure Modeling Approach to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site* (EHS Support, 2018 and EHS Support, 2019b), which stated that the surface water EPCs for small-range receptors in terrestrial exposure areas would be calculated based on a subset of surface water features closest to the target exposure area. After an initial review of the data, it was determined that performing these extra calculations was not necessary and did not add any information to the BERA that would affect conclusions. For example, for most constituents and receptors, less than 1 percent of the total dose originated from drinking water ingestion. Furthermore, the maximum concentration and the UCL_{mean} for each water body were used as the EPCs for the transitional and aquatic food chain models. Thus, any potential impacts associated with drinking water from the individual water sources at the Site were clearly demonstrated in the modeling performed for the transitional or aquatic exposure area in which they were located. Calculating an EPC based on a combination of multiple water bodies based on proximity would be unnecessary, particularly when the results from the individual surface water bodies resulted in very low exposure resulting from drinking water ingestion. The use of the site-wide and exposure area-wide maximum concentrations in the screening-level wildlife ingestion evaluation and the site-wide and exposure area-wide UCL_{mean} values in the refined wildlife ingestion evaluation provide sufficient information to identify potential risks associated with drinking water under conservative and more representative exposure scenarios.

5.3.3.4 Model Parameters

Dietary exposure models include parameters relating to receptor-specific exposure factors, EPCs, and AUFs. Exposure factors refer to receptor-specific variables (e.g., BW, FIR_{fw}, SIR, WIR), which are typically derived from literature sources. Exposure variables refer to site-specific measurements, namely COPEC concentrations estimated in exposure media. The approach for estimating exposure factors and variables for wildlife ingestion pathways is summarized below. The receptor-specific exposure parameters for each surrogate receptor used in the dietary exposure modeling are presented in the wildlife exposure modeling interim deliverable that was submitted and approved prior to the initiation of the BERA. The interim deliverable is presented in **Appendix A2.**

The USEPA *Wildlife Exposure Factors Handbook* ("the Handbook" [USEPA, 1993]) was the primary data source of exposure factors for the wildlife receptor species used to represent the receptor categories identified in the ECSM (**Section 3.6**). Additional receptor-specific literature sources were also used to supplement exposure data compiled in the Handbook (e.g., USACHPPM, 2004). Deterministic exposure modeling uses exposure factors that are representative of typical or average (e.g., mean parameter) exposure conditions.

Based on the conceptual study design, dietary pathways were evaluated based on the estimates of the bioaccumulation of COPECs into dietary items from soil, sediment, and surface water pathways. Concentrations of COPECs in dietary items were estimated using conservative assumptions of BAFs, biota-sediment accumulation factors (BSAFs) from sediment, or bioconcentration factors (BCFs) from surface water. The wildlife exposure modeling interim deliverable in **Appendix A2** summarizes the bioaccumulation models used to support dietary modeling in the BERA.

5.4 Risk Calculation

Potential risks associated with exposure estimates presented in the BERA are expressed as HQs, and are calculated as the ratio of the EPC to ESV for the direct contact pathway and the summed EDD for ingestion pathways to the TRV for ingestion pathways, as follows:

$$HQ = \frac{EPC}{ESV} or \frac{EDD}{TRV}$$

Potential ecological risk may be characterized based on HQs for direct and ingestion pathways, as follows:

- $HQs_{NOEC/NOAEL}$ less than or equal to 1.0 indicates limited potential for adverse effects because constituent concentrations result in an exposure that has not been demonstrated to cause adverse ecological effects.
- $HQs_{NOEC/NOAEL}$ greater than 1.0 indicates that an EPC or EDD for the constituent exceeds an ecological benchmark representing a NOEC or NOAEL. The exposure may or may not constitute an actual risk; however, the potential for adverse effects cannot be dismissed and further evaluation is warranted.

HQs calculated based on LOEC ESVs or TRV_{LOAEL} were used to assess the likelihood of adverse effects based on exposure to concentrations or doses known to be associated with an adverse effect on survival, growth, or reproduction. The relative frequency and magnitude of LOEC ESVs or TRV_{LOAEL} exceedances were used to identify potential risk drivers within receptor groups and exposure areas.

6 Baseline Risk Estimates and Risk Characterization

Risk characterization in the BERA focuses on establishing causal relationships, if present, between ecological effects and site-specific exposure to COPECs. A description of potential ecological risks is documented in the BERA for each assessment endpoint based on the findings and interpretations of risk estimates from corresponding measurement endpoints. The risk description provides a weight-of-evidence evaluation of the likelihood and ecological significance of the estimated risks and may be used to support risk management decision-making (USEPA, 1997). Key elements included in the BERA risk description include:

- Identifying thresholds for ecological effects for observed exposure-response relationships;
- Estimating the likelihood of adverse ecological effects;
- Evaluating the spatial extent of ecological risk within exposure areas; and,
- Assessing the potential for identified risks to persist in the future, considering the potential for natural recovery once the sources of COPECs or migration pathways to the exposure area are mitigated.

This section presents risk estimates for direct contact and ingestion pathways and characterizes risk for individual exposure areas within the terrestrial, transitional, and aquatic habitat categories. Along with wildlife ingestion summaries and small range receptor exceedance maps, direct contact risk estimates are presented in **Table 6-1** through **Table 6-56** and **Figure 6-1** through **Figure 6-41**. **Appendix H** includes receptor- and exposure-area specific wildlife ingestion modeling calculations for the screening-level (**Appendix H1**) and refined (**Appendix H2**) model scenarios. Screening-level and refined modeling results are summarized in **Table 6-57** through **Table 6-59**. **Table 6-57** presents an overall summary of COPECs with an HQ_{NOAEL} that exceeded 1 in the screening-level evaluation. **Table 6-58** presents the numerical results of the refined evaluation, which calculated spatially weighted HQs based on exposure to exposure areas within a given receptor home range. Therefore, the HQs presented in **Table 6-58** represent exposure to the target and adjacent exposure areas within the home range for each receptor, using the weighting factors for exposure presented in **Table 5-7**. **Table 6-59** presents HQs using the refined EPCs (i.e., UCL_{mean} values), but the calculations assumed that the entire exposure for a given species was obtained within the target exposure area (i.e., the AUF was set to 1). These results provide a clearer visualization as to where potential risks are originating from between exposure areas. For example, using the spatially weighted approach presented in **Table 6-58**, a medium- or large-range receptor being evaluated for a relatively small exposure area (e.g., the Cedar Creek Reservoir Overflow Ditch) may exhibit high HQs for some constituents that are present primarily or even exclusively in adjacent exposure areas. By cross-checking against the results in **Table 6-59**, it can readily be observed whether the risk is originating at the target or adjacent exposure areas. The following subsections present the output of the exposure estimate and risk characterization, which provides the basis for the BERA conclusions and recommendations.

6.1 Terrestrial Exposure Areas

The following sections present risk estimates and risk characterizations for exposure areas within terrestrial habitats at the Site.

6.1.1 Main Plant Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the Main Plant Area.

6.1.1.1 Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to surface soil within the Main Plant Area indicates limited potential for adverse ecological effects associated with exposure to LMW and HMW PAHs. No COPECs were detected at concentrations exceeding LOECs for terrestrial plants and soil invertebrates in the Main Plant Area. The greatest exposure to soil invertebrates was associated with exposure to LMW and HMW PAH exposure in surface soil. Maximum exposure concentrations exceeded soil invertebrate NOECs for LMW PAHs (HQ_{NOEC} = 19) and HMW PAHs (HQ_{NOEC} = 35.7), with minor exceedances for arsenic (HQ_{NOEC} = 1.3), mercury (HQ_{NOEC} = 5.4), and zinc (HQ_{NOEC} = 2.0; **Table 6-1**). Based on refined EPCs, COPECs were below NOEC values for soil invertebrates, except for exposure to LMW PAHs (HQ_{NOEC} = 2.2) and HMW PAHs (HQ_{NOEC} = 4.3).

Maximum exposure concentrations resulted in minor exceedances of terrestrial plant NOECs for nickel (HQ_{NOEC} = 3.7), selenium (HQ_{NOEC} = 1.3), and zinc (HQ_{NOEC} = 1.5); however, terrestrial plant NOECs were not available for LMW and HMW PAHs (**Table 6-1**). Refined EPCs were below available NOEC values for terrestrial plants.

Figure 6-1 illustrates the spatial distribution of sampling stations within the Main Plant Area that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Exceedances of NOECs were primarily associated with exposure to PAHs and select metals at soil sampling stations in the north-central portion of the Main Plant Area.

6.1.1.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to soil in the Main Plant Area and used maximum concentrations as the EPCs resulted in HQs exceeding 1 for all receptors except for the long-tailed weasel and the North American wolverine (**Table 6-57**). Exposure to PAHs, BEHP, and dioxins resulted in the highest HQs within this exposure area (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in several constituents having an HQ greater than 1, but only HMW PAHs (American woodcock and yellow-billed cuckoo) had HQ_{LOAEL} values that exceeded 1 (**Table 6-2, 6-58**). The yellow-billed cuckoo, currently listed as a federally threatened species, had HQ_{NOAEL} values that equaled 1 for LMW PAHs and exceeded 1 for HMW PAHs (19.7), BEHP (4.2), and dioxins/furans (2.7; **Tables 6-2, 6-58**). All HQ_{LOAEL} values were less than 5. Approximately 99 percent of the woodcock dose and 82 percent of the yellow-billed cuckoo dose that resulted in the LOAEL exceedances were associated with ingestion of earthworms (**Appendix H**).

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the Main Plant Area, the dose associated with PAHs in soil associated with risk to the American woodcock and yellow-billed cuckoo originates entirely from the

Main Plant Area, assuming exclusive foraging within this exposure area (**Table 6-59**). Furthermore, PAHs were not determined to be background-related by the background hypothesis testing evaluation performed for this exposure area (Roux, 2019).

The results of the small range receptor evaluation for the Main Plant Area are presented in **Figure 6-2**. Similar to the spatial distribution of direct contact exceedances, a cluster of stations in the north-central portion of the main industrial complex near the location of the former Paste Plant had concentrations that exceeded the NOAEL-based soil benchmark and some that exceeded the LOAEL-based soil benchmark for the short-tailed shrew. A few additional sample locations (CFSB-080 and CFSB-236) to the southeast of the main industrial complex in the vicinity of the Rectifier Yards also had concentrations that exceeded the LOAEL-based benchmark for the short-tailed shrew. Most of the samples around the periphery of the Main Plant exposure area either did not exceed either benchmark, or only exceeded the NOAEL-based benchmark (but not the LOAEL-based benchmark) for small range receptors.

6.1.1.3 Risk Characterization

Risk estimates for the Main Plant Area indicate the potential for adverse effects associated with exposure to PAHs in soil within localized portions of the Main Plant Area in close proximity to former operations. Direct contact exposure to PAHs in Main Plant Area may potentially result in adverse effects to terrestrial invertebrates in these localized areas. Maximum and refined EPCs exceeded NOECs; LOEC values were not available. Risk to plants via direct contact is expected to be negligible.

Based on refined exposure modeling that assumed that the Main Plant Area was the center of the home range of each receptor, estimated doses of PAHs resulted in wildlife ingestion HQ_{NOAEL} (for the yellow-billed cuckoo) or HQ_{LOAEL} values that exceeded 1 for the American woodcock and yellow-billed cuckoo. The ingestion of terrestrial invertebrates in the diet was the critical exposure pathway for these constituents for both receptors. Most of the samples with the highest concentrations of HMW PAHs were in the north central to eastern portion of the Main Plant Area.

BEHP also had HQ_{LOAEL} values that exceeded 1, but BEHP is a common laboratory contaminant, and its presence is unlikely to be site-related. Because of its current status as a federally threatened species, the yellow-billed cuckoo is evaluated on the basis of NOAEL endpoints. The yellow-billed cuckoo had HQ_{NOAEL} values that exceeded 1 for HMW PAHs (19.7), BEHP (4.2), and dioxins/furans (2.7; **Table 6-2, Table 6-58**). However, there is a low probability that yellow-billed cuckoo would be present in the vicinity of the site and, if present, it would not likely be exposed to soil in the Main Plant Area based on the limited availability of suitable habitat. Only 38 observations of the yellow-billed cuckoo have been recorded in the Montana Natural Heritage Program Database for the state of Montana. Recorded observations occurred from May to July (MNHP, 2019). If present in the vicinity of the Site, the yellow-billed cuckoo prefers open woodlands with dense, scrubby understory that provide cover, particularly willow or cottonwood-dominated forest canopies, with water nearby (Hughes, 2015). The Western subspecies that would potentially occur at the Site requires patches of at least 10 hectares (25 acres) of dense, riparian forest with a canopy cover of at least 50 percent in both the understory and overstory (MNHP, 2019). Under current conditions, the Main Plant Area is disturbed habitat that lacks wooded habitat; therefore, suitable habitat to support the yellow-billed cuckoo is not present.

The refined exposure models may also overestimate the potential dose to the yellow-billed cuckoo based on estimates of dietary dose based on terrestrial invertebrates (e.g., earthworms). No dietary information is available specific to Montana, but in other parts of the range, the main diet of the yellow-billed cuckoo is caterpillars. Other insects, some fruits, and sometimes small lizards, frogs, and bird eggs area also consumed. Thus, the assumption in the wildlife ingestion model that the yellow-billed cuckoo diet consists entirely of terrestrial invertebrates is likely conservative; the soil-to-earthworm pathway typically results in higher exposure doses than other pathways, and the assumption that a target receptor ingests terrestrial invertebrates exclusively rather than a mixture of invertebrates and other food items would result in an overestimation of dose for most constituents. Given that the uptake factors for terrestrial invertebrates in the wildlife ingestion model are based on uptake to earthworms, exposure estimates presented in the BERA likely overestimate exposure relative to more representative dietary items for the yellow-billed cuckoo. Because caterpillars and other documented prey items have much less direct contact with soil than earthworms, they would likely bioaccumulate lower COPEC concentrations from soil.

In summary, because of the low number of records in Montana, the lack of its preferred riparian habitat at the Main Plant Area, and its migratory status, it is highly unlikely that the yellow-billed cuckoo is regularly, if ever, present at the Site in general and in the Main Plant Area specifically. Wildlife ingestion assumptions that assume 100 percent ingestion of earthworms likely overestimate risk. These factors should be considered collectively by risk managers when judging the potential for adverse impacts to this threatened species at the Site.

Potential risks to small range receptors were also noted in the Main Plant Area, particularly in the north-central and southeastern portions of the exposure area where some samples exceeded LOAEL-based benchmarks protective of mammalian receptors with limited home ranges, particularly short-tailed shrew. PAHs were detected at concentrations that were elevated compared to background areas.

Based on these findings, there is some potential for adverse effects to ecological receptors in localized areas of the Main Plant Area under current conditions. However, concern regarding constituents in the Main Plant Area are reduced because of the low quality of habitat in the area under current exposure conditions. The Main Plant Area is located in a disturbed, industrial setting with significant portions of it covered by concrete. Thus, it has poor quality resources that most species require for regular use (i.e., foraging areas, vegetative structure used for nesting or bedding areas and protection from predators, water sources). Specifically, the Main Plant Area does not provide habitat for yellow-billed cuckoo, which requires dense, wooded cover (**Section 3.3.6 and 6.1.1.2**). Therefore, ecological exposure is likely to be reduced or incomplete compared to more natural settings with higher habitat quality. Ecological risks are likely overestimated under current conditions and exposure assumptions for the Main Plant Area due to reduced or incomplete exposure pathways; however, further evaluation of exposure to soils with elevated concentrations in the identified localized areas may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

6.1.2 Central Landfills Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the Central Landfills Area.

6.1.2.1 Direct Contact Exposure Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil within the Central Landfills Area indicates limited potential for adverse ecological effects associated primarily with cyanide, metals, and PAHs. In the 0-0.5-ft and 0.5-2-ft sampling intervals, maximum concentrations of soil COPECs were less than available soil invertebrate LOECs, except for copper (HQ_{LOEC} = 13.7; **Table 6-3**). Maximum concentrations exceeded soil invertebrate NOECs for several metals, with HQ_{NOEC} values ranging from 1.9 for nickel to 90.8 for copper (**Table 6-3**). Maximum concentrations of LMW PAHs (HQ_{NOEC} = 33) and HMW PAHs (HQ_{NOEC} = 27) exceeded NOECs for soil invertebrates (**Table 6-3**). Based on refined EPCs for soil invertebrates, cyanide and metal COPEC concentrations were below NOEC values, except for minor exceedances for copper (HQ_{LOEC} = 1.4). Refined risk estimates for LMW PAHs and HMW PAHs resulted in HQ_{NOEC} = 3.0 (**Table 6-3**); soil invertebrate LOECs for LMW and HMW PAHs were not identified.

For terrestrial plants, maximum concentrations of soil COPECs were less than available LOECs for COPECs, except for copper (HQ_{LOEC} = 14.8; **Table 6-3**). Maximum concentrations exceeded terrestrial plant NOECs for cyanide (HQ_{LOEC} = 2.0) and several metals, with HQ_{NOEC} values ranging from 1.9 for beryllium to 104 for copper (**Table 6-3**). Concentrations of organic COPECs exceeding terrestrial plant NOECs were limited to slight exceedances of 3- and 4-methylphenol (HQ_{NOEC} = 1.5) and dibenzofuran (HQ_{NOEC} = 2.5). Based on refined EPCs, cyanide and metal COPEC concentrations were below NOEC values, except for a minor copper exceedance for (HQ_{LOEC} = 1.5).

The spatial distribution of sampling stations within the Central Landfills Area that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities is illustrated in **Figure 6-3**[3]. Elevated HQ_{NOEC} values for copper were driven by the single result at CFSB-002, which had a concentration of 7,260 mg/kg. This concentration was an order of magnitude greater than the next highest concentration of 721 mg/kg and was nearly two orders of magnitude greater than the mean concentration of copper (81 mg/kg) detected in all Central Landfills Area soil samples. Copper concentrations at other stations within the Central Landfills Area were less than LOECs for terrestrial plants and soil invertebrates. Excluding the anomalous copper result of 7,260 mg/kg, the refined direct contact EPC was 16.74 mg/kg, which is lower than terrestrial plant and soil invertebrate NOEC values and the SO#1 BTV of 17.93 mg/kg. Therefore, this elevated detection is considered anomalous and not representative of exposure within the Central Landfills Area. Barium and manganese exceedances of LOECs for terrestrial plants and soil invertebrates were distributed throughout the Central Landfills Area; however, concentrations of these metals were determined to be comparable to background concentrations in hypothesis testing (Roux, 2019). Exceedances of LOECs for other metals were associated with landfill cover stations CFLP-009 and CFLP-012 near the center of the exposure area within the footprint of the Wet Scrubber Sludge Pond (**Figure 6-3**).

6.1.2.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to soil in the Central Landfills Area and used maximum concentrations as the EPCs resulted in HQs exceeding 1 for all receptors except for the long-tailed weasel and the North American wolverine (**Table 6-57**). Exposure to copper, Aroclor 1254, and PAHs resulted in the highest HQs within this exposure area (**Appendix H**).

[3] Samples designated with the prefix CFLP- indicate samples represent landfill cover materials.

The refined food chain model using more realistic assumptions resulted in several constituents having an HQ greater than 1, but only copper (American woodcock, yellow-billed cuckoo), Aroclor 1254 (American woodcock, yellow-billed cuckoo), and HMW PAHs (yellow-billed cuckoo) had HQ_{LOAEL} values that exceeded 1. All HQ_{LOAEL} values were less than 5, however (**Tables 6-4 and 6-58**). For copper, over 85 percent of the dose to the woodcock, and nearly the entire dose to the cuckoo was associated with ingestion of terrestrial invertebrates in their diet. Nearly the entire dose of Aroclor 1254 for the woodcock and the cuckoo, and of HMW PAHs for the cuckoo was also attributable to ingestion of terrestrial invertebrates for these two receptors (**Appendix H**). The yellow-billed cuckoo, which is evaluated using NOAEL endpoints, also had HQ_{NOAEL} values that exceeded 1 for LMW PAHs, BEHP, and dioxins/furans.

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the Central Landfills Area, the dose associated with copper, Aroclor 1254, and PAHs in soil associated with risk to the American woodcock and yellow-billed cuckoo and the dose associated with LMW PAHs, BEHP, and dioxins/furans that resulted in HQ_{NOAEL} values slightly greater than 1 for the yellow-billed cuckoo, originate entirely from the Central Landfills Area (**Table 6-59**). Neither copper nor PAHs were determined to be background-related by the background hypothesis testing evaluation performed for this exposure area (Roux, 2019). The EPCs for copper in soil in this exposure area were approximately an order of magnitude greater than the SO#1 BTV of 17.93 mg/kg. However, as discussed in **Section 6.1.2.1**, the single sample with elevated copper that strongly influenced the EPC at this exposure area is considered to be anomalous. To determine the influence of the anomalous sample on the calculated risk estimates for wildlife receptors, a refined EPC for copper was calculated after excluding the elevated concentration of 7,260 mg/kg. The resulting EPC of 16.74 mg/kg was an order of magnitude lower than the EPC with the anomalous sample included, and the NOAEL- and LOAEL-based HQs for all wildlife receptors using this revised EPC were all below 1.

The results of the small range receptor evaluation for the Central Landfills Area are presented in **Figure 6-4**. Several sample locations (CFSB-004, CFLP-009, and CFLP-012) had concentrations exceeding the LOAEL-based benchmark for the short-tailed shrew in the area where the Wet Scrubber Sludge Pond was formerly located. Several other locations in the southern portion of the exposure area (CFSB-227 and CFSB-224) between the Wet Scrubber Sludge Pond and the Main Plant Area also contained concentrations, including Aroclor 1254, exceeding the LOAEL-based benchmark for the short-tailed shrew. Several samples from this portion of the exposure area also had constituents at concentrations exceeding NOAEL, but not LOAEL benchmarks (with the exception of CFSB-002, where the anomalous copper concentration exceeded the LOAEL benchmark) for one or both small range receptors.

6.1.2.3 Risk Characterization

Risk estimates for the Central Landfills Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals, including copper, in soil within localized areas near the former Wet Scrubber Sludge Pond. The direct contact risk evaluation performed at the Central Landfills exposure area indicates that potential risk to soil invertebrates and terrestrial plants is low. Refined risk estimates for soil invertebrates exceeded NOECs for copper, LMW PAHs, and HMW PAHs; refined risk estimates for terrestrial plants exceeded NOECs for beryllium, copper, manganese, and thallium (**Table 6-3**). Greatest HQ_{LOEC} values for soil invertebrates and terrestrial plants were identified for copper; however, EPCs for copper were driven by a single result at CFSB-002 (7,260 mg/kg); copper concentrations at other stations within the Central Landfills Area were over two orders of magnitude lower and were less than LOECs for terrestrial plants and soil invertebrates. HQ_{NOEC} values for LMW and HMW PAHs differed by an order of magnitude based on whether they were calculated using the maximum or refined EPCs, indicating that localized stations with elevated PAH concentrations are driving risk estimates (**Table 6-3**).

Wildlife ingestion models indicate the potential for adverse effects associated with exposure to copper, PAHs, and Aroclor 1254 assuming conservative exposure assumptions. Copper in Central Landfills Area soil also resulted in HQ_{LOAEL} values that exceeded 1 for the American woodcock and yellow-billed cuckoo for wildlife ingestion pathways. Hypothetical exposure to Aroclor 1254 (American woodcock, yellow-billed cuckoo), and HMW PAHs (yellow-billed cuckoo), also resulted in HQ_{LOAEL} values greater than 1. The ingestion of terrestrial invertebrate prey items was the critical exposure pathway for all COPECs and receptors. Similar to the direct contact pathways, EPCs for copper and PAHs resulting in elevated doses in the wildlife ingestion models are likely driven by localized stations with elevated concentrations. The greatest concentrations of Aroclor 1254 were associated with stations CFSB-227 and CFSB-224 in the southern portion of the exposure area between the Wet Scrubber Sludge Pond and the Main Plant Area. As noted above, the copper HQ values were driven by the single anomalous high concentration at CFSB-002. The small range receptor evaluation indicated several sample locations (e.g., CFLP-009, CFSB-004, CFLP-012, CFSB-227, CFSB-224) with concentrations exceeding the LOAEL-based soil benchmarks for the short-tailed shrew in the area where the Wet Scrubber Sludge Pond was formerly located and in the southern portion of the exposure area between the Wet Scrubber Sludge Pond and the Main Plant Area.

Because of its threatened status, the yellow-billed cuckoo is evaluated on the basis of NOAEL endpoints. In addition to copper, Aroclor 1254, and Total HMW PAHs, the yellow billed cuckoo had HQ_{NOAEL} values that exceeded 1 for LMW PAHs (1.4), BEHP (2.2), and dioxins/furans (1.1; **Table 6-58**). However, as stated for the Main Plant Area (see **Section 6.1.1.3**), the probability of yellow-billed cuckoo being exposed to COPECs in soil in the Central Landfills Area is low given the infrequent observations of yellow-billed cuckoo in the region and the lack of suitable habitat in the Central Landfills Area. Similar to the Main Plant Area, the Central Landfills Area lacks the open woodlands with dense, scrubby understory that the yellow-billed cuckoo requires. Further, the estimation of dietary dose to the yellow-billed cuckoo based on uptake to earthworms likely overestimates exposure experienced through the ingestion of more representative dietary items (see **Section 6.1.1.3**). Based on the low probability of exposure in the Central Landfills Area and the conservative estimate of dietary COPEC concentrations, HQs for the yellow-billed cuckoo are likely overestimated, particularly when only HQ_{NOAEL} values are considered.

Based on these findings, there is limited potential for adverse effects to ecological receptors exposed to copper, PAHs, and Aroclor 1254 in localized areas of the Central Landfills Area under current conditions. Neither copper nor PAHs were determined to be background-related by the background hypothesis testing evaluation performed for this exposure area. Therefore, copper, PAHs, and Aroclor 1254 were considered to be site-related constituents with the potential to result in adverse effects in localized areas identified within the Central Landfills Area. However, the risk associated with copper exposure was strongly influenced by a single highly elevated concentration that is considered to be anomalous. All wildlife receptor HQs were below 1 using an EPC that was calculated with the anomalous concentration excluded. Also, the potential for adverse effects associated with COPECs in soil in the Central Landfills Area is limited because of the low quality of habitat in the area that reduces receptor use and exposure. The Central Landfills Area is located in an industrial setting that has poor quality resources that most species require for regular use (i.e., foraging areas, vegetative structure used for nesting or bedding areas and protection from predators, water sources). Specifically, the Central Landfills Area does not provide habitat for yellow-billed cuckoo, which require dense, wooded cover (**Section 3.3.6**). Ecological risks are likely overestimated under current conditions and exposure assumptions for the Central Landfills Area due to reduced or incomplete exposure pathways; however, further evaluation of exposure to soils with elevated concentrations in the identified localized areas may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

6.1.3 Incremental Soil Sampling Grid

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the ISS Grid. The ISS Grid is located primarily in the Central Landfills Area, with a portion of the DUs in the northern portion of the Main Plant Area (**Figure 4-8**).

6.1.3.1 Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil within the ISS Grid was performed using the upper RSD-adjusted EPCs (see **Section 4.1.1.1**). The results indicate limited potential for adverse ecological effects associated primarily with cyanide, metals, and PAHs. Maximum concentrations of soil COPECs were lower than available soil invertebrate LOEC values, except for copper (HQ_{LOEC} = 1.9) and zinc (HQ_{LOEC} = 2.1; **Table 6-5**). Maximum concentrations exceeded soil invertebrate NOECs for arsenic, copper, manganese, mercury, selenium, and zinc, with HQ_{NOEC} values ranging from 2.0 (manganese) to 16.2 (zinc; **Table 6-5**). Maximum concentrations of LMW PAHs (HQ_{NOEC} = 129.9) and HMW PAHs (HQ_{NOEC} = 112..5) exceeded NOECs for soil invertebrates (**Table 6-5**); soil invertebrate LOECs for LMW and HMW PAHs were not identified.

Maximum concentrations of soil COPECs exceeded terrestrial plant LOECs for barium (HQ_{LOEC} = 1.3), copper (HQ_{LOEC} = 2.0), lead (HQ_{LOEC} = 1.1), selenium (HQ_{LOEC} = 5.3), zinc (HQ_{LOEC} = 2.4; **Table 6-5**) and dibenzofuran (HQ_{LOEC} = 1.5). Maximum concentrations exceeded terrestrial plant NOECs for cyanide (HQ_{LOEC} = 4.0) and several metals, with HQ_{NOEC} values ranging from 1.1 for cobalt to 30.7 for selenium (**Table 6-5**). The maximum concentration of dibenzofuran (HQ_{NOEC} = 15.3) also exceeded the terrestrial plant NOEC. 2,4-Dimethyphenol exceeded its terrestrial plant NOEC (HQ_{NOEC} = 71), but a terrestrial plant LOEC was not identified for this compound, and it was only detected in two ISS samples at a maximum concentration of 0.7 mg/kg (**Table 6-5**).

Figure 6-5 illustrates the spatial distribution of sampling stations within the ISS Grid that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. The upper, measured, and lower RSD adjusted EPCs are represented by the three rows of results in the figure (because the four ISS grid areas with triplicate samples (CFISS-01, -04, -011, and -015) have EPCs based on calculated UCL_{mean} values rather than RSD adjusted concentrations, they have identical results for the three rows). Barium concentrations are likely associated with background soil conditions. Barium concentrations that exceed terrestrial plant LOECs were lower than or approximated the BTV (299.5 mg/kg) calculated for similar background soil type (SO#1); further, barium concentrations in surface soils from the Main Plant Area and Central Landfills Area that encompasses the ISS Grid were determined to be comparable to background concentrations in hypothesis testing (Roux, 2019). Exceedances of selenium were identified in contiguous DUs in the eastern portion of the ISS Grid, and exceedances of zinc were identified in two contiguous DUs in the southwestern corner of the ISS Grid (**Figure 6-5**).

6.1.3.2 Ingestion Risk Estimate

As discussed in **Section 4.1.1.1**, the Incremental Soil Sampling Grid was not included in the wildlife ingestion model. Potential risks to small-range receptors were evaluated using the point-by-point comparison to ESVs protective of the meadow vole and short-tailed shrew, as discussed below.

The results of the small range receptor evaluation for the Incremental Sampling Grid within the Operational Area are presented in **Figure 6-6**, which uses a similar 2-by-3 grid as **Figure 6-5** to depict exceedances for the short-tailed shrew and meadow vole across the three EPCs for each DU. Incremental samples in all DUs exceeded a NOAEL-based benchmark for at least one of the two evaluated small range receptors. Exceedances of the LOAEL-based benchmarks were limited to the southeastern (CFISS-033 and -044), north-central (CFISS-007, -011, -012, -013, and -020) and northwest-central (CFISS-003 and -004) DUs. All exceedances were associated with the short-tailed shrew receptor, except for CFISS-013, which also exceeded LOAEL-based benchmarks for the meadow vole. Exceedances of LOAEL-based benchmarks for short-tailed shrew were primarily associated with LMW and HMW PAH exposures. Several DUs located in the center of the Operational Area also had PCB-1254 concentrations that exceeded LOAEL-based benchmarks for the short-tailed shrew (**Figure 6-6**).

6.1.3.3 Risk Characterization

Risk estimates for the ISS Grid were similar to risk estimates for overlapping areas within the Main Plant Area and Central Landfills Area. Direct contact exposure to soil invertebrates was greatest for PAHs and select metals, including copper and zinc. The greatest exposure to terrestrial plants was associated with exposure to selenium, copper, and zinc. However, risk estimates based on maximum EPCs resulted in $HQ_{LOEC} < 5$ (when rounded) for terrestrial plants and soil invertebrates.

Effects associated with wildlife ingestion pathways were evaluated for the ISS Grid using comparisons of NOAEL- and LOAEL-based benchmarks for small range receptors to EPCs estimated for individual DUs. Several of the DUs, particularly in the central third of the ISS Grid within the Central Landfills Area, had concentrations of constituents that exceeded LOAEL-based benchmarks protective of small range receptors. Exceedances of LOAEL-based benchmarks in these DUs were primarily associated with LMW and HMW PAH exposure to the short-tailed shrew. Exposure to Aroclor 1254 also resulted in LOAEL-based exposure to the short-tailed shrew in five of these DUs.

Because of the exceedances of LOEC/LOAEL benchmarks, there is some potential for adverse effects associated with exposure to copper, selenium, and PAHs in soil in select DUs. However, because the exceedances were relatively low, risk is considered moderate. PAHs in soil may also represent a risk to ecological receptors, particularly soil invertebrates. However, because of the lack of LOEC values, the potential risk to these receptors is an uncertainty. PAHs were found to be elevated relative to background in the hypothesis testing evaluation performed for the Central Landfills and Main Plant exposure areas, which overlap the ISS Grid. Similar to the Main Plant Area and Central Landfills Area, concern regarding exposure to COPECs in the ISS Grid are reduced because of the low quality of habitat in the area. The ISS Grid is located in an industrial setting with poor habitat quality and limited resources that are required by most species for regular use. Ecological risks are likely overestimated under current conditions and exposure assumptions for the ISS Grid due to reduced or incomplete exposure pathways;

however, further evaluation of exposure to soils with elevated concentrations in the identified DUs may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

As described in **Sections 5.3.1** and **6.1.3.3**, soil EPCs based on individual DUs within the Operational Area ISS sampling grid were compared to benchmark values protective of small range receptors that would be expected to obtain their entire exposure within the approximately 1-acre sized DUs. Discrete soil samples that were also collected from within the ISS grid as part of the broader Site characterization effort were pooled with other discrete samples from the Main Plant Area or Central Landfills Area, which are the two exposure areas that overlap the Operational Area. The discrete soil sample dataset was used to evaluate potential risks associated with direct contact and indirect/food chain effects for a variety of receptors selected to represent the trophic positions of ecological species likely to be present. Discrete samples across the Site were also individually compared to calculated benchmark concentrations protective of small-range receptors (i.e., the meadow vole and short-tailed shrew).

As stated in the BERA Work Plan (EHS Support, 2018) and *Technical Memorandum: Proposed Wildlife Exposure Modeling Approach to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site* presented in **Appendix A2**, exposure to receptors with moderately sized home ranges that may forage within multiple, adjacent DUs within the ISS grid was not quantified. This results in some uncertainty regarding potential risk to receptors with home ranges larger than an acre but smaller than the 43-acre Operational Area, including the American woodcock (11.1 acre home range), yellow-billed cuckoo (42 acre home range), and the long-tailed weasel (12 acre home range) that may forage exclusively within the Operational Area.

The uncertainty regarding the lack of evaluation of mid-range receptors is reduced based on the evaluation of relative exposure to small range receptor exposure and habitat quality within the Operational Area. HQs for small range receptors are typically higher than larger range receptors, owing to the fact that small range receptors (such as the meadow vole and short-tailed shrew) are smaller in size and have a higher relative metabolic/ingestion rate (and, therefore, calculated constituent dose) per unit body weight than larger species within the same foraging guild (USEPA, 2005b). Thus, evaluations and conclusions protective of small home range receptors are likely also protective of larger range receptors. The analysis of concentrations present at each DU and the comparison to NOAEL-based and LOAEL-based benchmark values for the meadow vole (herbivore) and short-tailed shrew (insectivore) presented in Section 6.1.3.2 indicated that most DUs within the Operational Area had constituent concentrations that were below LOAEL-based benchmarks, but 10 ISS locations primarily within the center of the sampling grid had concentrations that exceeded LOAEL-based benchmarks. Although one of the mid-range receptors of concern (the long-tailed weasel) is a carnivore, which is a foraging guild not represented by the two species used to develop wildlife benchmarks for the point-by-point analysis, and another (the yellow-billed cuckoo) is an avian species that may have somewhat different toxicity thresholds than the mammalian small-range receptors upon which the small-range receptor benchmarks were developed, risk management decisions based upon small body weight herbivores and insectivores are likely to also be protective of these receptors with mid-sized home ranges. This is supported by the fact that the mammalian insectivore exposure pathway (represented by the short-tailed shrew) typically results in the highest dose among wildlife receptors. Also, the home ranges of two of the three mid-range receptors listed above are approximately double the size of the six 1-acre DUs where LOAEL-based benchmarks were exceeded, and the third (the yellow-billed cuckoo) approximates the size of the entire Operational Area. Therefore, some dilution of dose based on exposure to less contaminated areas would result in a lower expected likelihood of adverse effects to the three mid-range receptors of concern compared to the 1-acre exposure areas assumed for the short-tailed shrew and meadow vole.

A second consideration that reduces the uncertainty for mid-range receptors is that the Operational Area is in an area that was highly disturbed by plant operations and lacks sufficient habitat to sustain 100 percent of the foraging requirements of mid-range receptors. Habitat qualities favored by the evaluated mid-range receptors such as forest thickets (American woodcock), seral ecotones and forests with openings (long-tailed weasel), and dense, riparian forest with canopy cover of at least 50 percent (yellow-billed cuckoo) are absent in this portion of the Site. Therefore, the potential for the occurrence of such receptors is low. Although irregular exposure may occur, it is unlikely that the habitat present in this area would support multiple individuals foraging 100 percent of the time within the Operational Area. Thus, the potential for adverse effects to populations associated with the receptor groups represented by the American woodcock and long-tailed weasel, is highly unlikely due to the absence of a sufficient forage base to sustain populations of these receptor groups. The yellow-billed cuckoo is a threatened species that is protected on the individual level. However, as stated previously for the Main Plant Area and Central Landfills Area, there is low probability of yellow-billed cuckoo to be present in the vicinity of the Site is due to its rarity in Montana in general, and an even lower probability of occurrence within the Operational Area due to the absence of basic habitat requirements (see **Section 6.1.1.3**).

Based on the information presented in the preceding paragraphs, it is unlikely that the lack of evaluation of receptors with mid-sized home ranges within the Operational Area represents a significant uncertainty in the BERA. Risk management decisions based on the sessile and small-range receptors that are currently the focus of evaluation in this area are likely to be protective of larger-ranging receptors as well.

6.1.4 Industrial Landfill Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the Industrial Landfill Area.

6.1.4.1 Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil within the Industrial Landfill Area indicates limited potential for adverse ecological effects associated primarily with PAHs and select metals. In the 0-0.5-ft and 0.5-2-ft sampling intervals, maximum concentrations of soil COPECs were less than available soil invertebrate LOECs; however, soil invertebrate LOECs for PAHs were not identified (**Table 6-6**). Maximum concentrations exceeded soil invertebrate NOECs for arsenic (HQ_{NOEC} = 3.5), nickel (HQ_{NOEC} = 1.7), and LMW (HQ_{NOEC} = 7.0) and HMW PAHs (HQ_{NOEC} = 13.4; **Table 6-6**). Refined risk estimates for soil invertebrates potentially exposed to arsenic, nickel, and LMW and HMW PAHs resulted in similar HQ_{NOEC} values to maximum EPCs.

For terrestrial plants, maximum concentrations of soil COPECs were less than available LOECs, except for nickel and vanadium (HQ_{LOEC} = 1.7 and HQ_{LOEC} = 2.1, respectively; **Table 6-6**). Maximum concentrations exceeded terrestrial plant NOECs for several metals, with HQ_{NOEC} values ranging from 1.3 for arsenic to 12.2 for nickel (**Table 6-6**). Refined EPCs were below terrestrial plant LOECs, except for minor exceedances for nickel (HQ_{LOEC} = 1.5) and vanadium (HQ_{LOEC} = 1.9).

Figure 6-7[4] illustrates the spatial distribution of sampling stations within the Industrial Landfill Area that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Direct contact LOEC exceedances were associated with maximum concentrations observed at station CFLP-005; concentrations at other Industrial Landfill Area stations were less than LOECs.

6.1.4.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to soil in the Industrial Landfill Area and used maximum concentrations as the EPCs resulted in HQs exceeding 1 for multiple receptors (**Table 6-57**). Exposure to PAHs resulted in the highest HQs within this exposure area (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in several constituents having an HQ greater than 1, but only nickel (American woodcock and short-tailed shrew) and HMW PAHs (American woodcock and yellow-billed cuckoo) had HQ_{LOAEL} values that exceeded 1 (**Tables 6-7 and 6-58**). All HQ_{LOAEL} values were less than 5, however. For nickel, approximately 90 percent of the dose to the woodcock and 99 percent of the dose to the shrew was associated with ingestion of terrestrial invertebrates. For HMW PAHs, approximately 94 percent of the dose to the woodcock and nearly the entire dose to the yellow-billed cuckoo was associated with ingestion of terrestrial invertebrates. The yellow-billed cuckoo, which is evaluated using NOAEL endpoints, also had an HQ_{NOAEL} value that exceeded 1 for nickel (2.3; **Tables 6-7** and **6-58**).

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the Industrial Landfill Area, the doses associated with nickel and PAHs in soil associated with risk to the American woodcock and yellow-billed cuckoo originate primarily from the Industrial Landfill Area (**Table 6-59**). Furthermore, neither nickel nor PAHs were determined to be background-related in the background hypothesis testing evaluation at this exposure area (Roux, 2019). Therefore, nickel and PAHs in soil at the Industrial Landfill Area represent a moderate risk to ecological receptors due to exposure from direct and indirect ingestion pathways.

The results of the small range receptor evaluation for the Industrial Landfill Area are presented in **Figure 6-8**. None of the four soil sample locations in the center and southwestern portion of the area had concentrations that exceeded LOAEL benchmarks. Both sample locations in the northeastern portion of the site (CFLP-005 and CFLP-006) had concentrations that exceeded NOAEL-based benchmarks for the meadow vole (HMW PAHs and nickel) and LOAEL benchmarks for the short-tailed shrew (HMW PAHs).

6.1.4.3 Risk Characterization

Risk estimates for the Industrial Landfill Area indicate the limited potential for adverse effects associated with exposure to PAHs and select metals in soil. Refined risk estimates for soil invertebrates exceeded NOECs for arsenic, nickel, LMW PAHs, and HMW PAHs; refined risk estimates for terrestrial plants exceeded NOECs for five metals (**Table 6-6**). The evaluation of direct contact pathways for soil invertebrates exposed to soil within the Industrial Landfill Area indicates the greatest potential for adverse effects is associated with exposure to LMW and HMW PAHs based on HQ_{NOEC} values; however,

[4] Samples designated with the prefix CFLP- indicate samples represent landfill cover materials.

the absence of soil invertebrate LOECs results in some uncertainty in the risk estimate. Direct contact impacts associated with soil constituents to terrestrial plants are expected to be low, due to no or very minor exceedances of terrestrial plant LOECs.

The results of the food chain model indicated that nickel (American woodcock and short-tailed shrew) and HMW PAHs (American woodcock and yellow-billed cuckoo) had HQ_{LOAEL} values that exceeded 1 in this exposure area. All HQ_{LOAEL} values were less than 5, however. Neither nickel nor PAHs were determined to be background-related. Also, two sample locations in the northeastern portion of the site exceeded LOAEL-based soil benchmarks for small range receptors. The ingestion of terrestrial invertebrate prey items was the critical exposure pathway for both nickel (American woodcock and short-tailed shrew, and the yellow-billed cuckoo when evaluated using the an HQ_{NOAEL}) and HMW PAHs (American woodcock and yellow-billed cuckoo). Therefore, nickel and PAHs in soil at the Industrial Landfill Area represent a moderate risk to ecological receptors due to exposure from direct and indirect ingestion pathways. Risk associated with nickel were driven by two highly elevated concentrations, both of which were in soil boring CFLP-005, which is in the northeastern portion of the exposure area. The concentration of nickel in the 0 to 0.5 ft sample at this location was 463 mg/kg and was 513 mg/kg in the 0.5 to 2 ft sample. Six additional soil samples exceeded the nickel BTV of 17.32 mg/kg in this exposure area as well. All other samples were below 100 mg/kg. Elevated HMW PAHs were also detected in CFLP-005 (0 to 0.5 ft) as well as CFLP-006 (0 to 0.5 ft), which is approximately 250 feet to the northwest of CFLP-005. Concentrations in these samples were over 100 mg/kg, at 166.6 mg/kg and 388 mg/kg, respectively. The deeper sample from CFLP-005 (0.5 to 2 ft) (91.2 mg/kg) and CFLP-003 (0.5-2 ft) (99 mg/kg) were also somewhat elevated (i.e., greater than 50 mg/kg). All other concentrations were below 50 mg/kg. Concern regarding COPEC exposure in the Industrial Landfill Area are reduced because of the disturbed and low quality of habitat in the area. The Industrial Landfill Area is a waste disposal area with limited resource qualities relative to more naturalized adjacent habitats. Due to the reasons stated in **Section 6.1.1.3**, the HQs for the cuckoo are likely overestimated based on the limited probability of occurrence of this species and the conservative estimate of dietary COPEC concentrations, particularly when only HQ_{NOAEL} values are considered. Specifically, the Industrial Landfill Area does not provide habitat for yellow-billed cuckoo, which require dense, wooded cover (**Section 3.3.6**). Ecological risks are likely overestimated under current conditions and exposure assumptions for the Industrial Landfill Area due to reduced or incomplete exposure pathways. It is also noted that the Industrial Landfill Area is uncapped. As such, the concentrations of COPECs may be reflective of the waste materials disposed of within the landfill.

6.1.5 Eastern Undeveloped Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the Eastern Undeveloped Area.

6.1.5.1 Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil within the Eastern Undeveloped Area indicates negligible potential for adverse ecological effects associated with select metals. In the 0-0.5-ft and 0.5-2-ft sampling intervals, maximum concentrations of soil COPECs were less than soil invertebrate LOECs available for COPECs (**Table 6-8**). Maximum concentrations exceeded soil invertebrate NOECs for five metals, with HQ_{NOEC} values ranging from 1.3 for zinc to 8.8 for manganese (**Table 6-8**). Based on refined EPCs, metal COPEC concentrations were below soil invertebrate NOEC values, except for barium (HQ_{LOEC} = 1.8) and manganese (HQ_{LOEC} = 3.2).

For terrestrial plants, maximum concentrations of soil COPECs were less than available LOECs, except for barium and manganese (HQ_{LOEC} = 4.1 and HQ_{LOEC} = 3.6, respectively; **Table 6-8**). Maximum concentrations exceeded terrestrial plant NOECs for five metals, with HQ_{NOEC} values ranging from 1.2 for selenium to 18 for manganese (**Table 6-8**). Refined EPCs were below terrestrial plant LOECs, except for minor exceedances for barium (HQ_{LOEC} = 2.2) and manganese (HQ_{LOEC} = 1.3; **Table 6-8**).

Figure 6-9 illustrates the spatial distribution of sampling stations within the Eastern Undeveloped Area that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Exceedances of barium and manganese on the eastern boundary of the Eastern Undeveloped Area were comparable to the BTVs calculated for barium (774 mg/kg) and manganese (1,566 mg/kg) for background soil area SO#4 that is typical of the Revett Formation soil type at the base of Teakettle Mountain (Roux, 2019). Exceedances to the west of the Cedar Creek Overflow Ditch are comparable to BTVs for barium (300 mg/kg) and manganese (1,566 mg/kg) calculated for the background soil area SO#1, which is representative of most of the developed portion of the Site (**Figure 6-9**). These findings indicate that direct contact exposure to barium and manganese are consistent with background exposure in the Eastern Undeveloped Area.

6.1.5.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to soil in the Eastern Undeveloped Area and used maximum concentrations as the EPCs resulted in HQ_{NOAEL} values exceeding 1 for four receptors (**Table 6-57**). However, all values were less than 5, and no HQ_{LOAEL} values exceeded 1 (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in two constituents having an HQ_{NOAEL} greater than 1 including nickel for the short-tailed shrew and BEHP (HQ =1.2) for the yellow-billed cuckoo (**Tables 6-9 and 6-58**). Neither of these HQ_{NOAEL} values were greater than 1 when rounded, and HQ_{LOAEL} values were less than 1. BEHP is also a common laboratory contaminant and is unlikely related to previous Site activities. Therefore, nickel and BEHP in soil at the Eastern Undeveloped Area represent a minimal risk to ecological receptors due to exposure from direct and indirect ingestion pathways.

The results of the small range receptor evaluation for the Eastern Undeveloped Area indicate that COPEC concentrations are below LOAEL-based benchmarks for meadow vole and short-tailed shrew at all sampling locations (**Figure 6-10)**. Stations along the eastern boundary of the Eastern Undeveloped Area and within the Borrow Pit Area exceed NOAEL-based benchmarks for nickel for short-tailed shrew, with a maximum HQ of 1.7. All sampling locations were below NOAEL-based benchmarks for the meadow vole.

6.1.5.3 Risk Characterization

Risk estimates for the Eastern Undeveloped Area indicate minimal potential for adverse effects associated with exposure to soil. Refined risk estimate indicates minor NOEC exceedances for soil invertebrates (barium and manganese) and terrestrial plants (barium, manganese, nickel, and thallium; **Table 6-8**). However, risks to soil invertebrates and terrestrial plant communities are considered to be negligible relative to background risk in the Eastern Undeveloped Area. Maximum concentrations for all constituents were below LOEC benchmarks for soil invertebrates, and refined EPCs for barium and manganese, which were detected at concentrations comparable to background, only marginally exceeded LOEC benchmarks for plants.

The wildlife ingestion model indicated that no HQ_{NOAEL} values exceeded 1 when rounded and all HQ_{LOAEL} values were less than 1 for all receptors. The estimated dose of BEHP for yellow-billed cuckoo slightly exceeded the NOAEL (HQ = 1.2; **Table 6-9**). Although the yellow-billed cuckoo is evaluated based on NOAEL endpoints due to its current status as a federally threatened species, the likelihood of adverse effects resulting from exposure to BEHP is low. As previously discussed, there is a low probability of occurrence of yellow-billed cuckoo at the Site and the dose that slightly exceeded the NOAEL TRV was based on the conservative estimate of dietary COPEC concentrations based on 100 percent ingestion of earthworms that likely overestimates COPEC concentrations in dietary items associated with the yellow-billed cuckoo (see **Section 6.1.1.3**). The small-range receptor evaluation did not identify any sample locations that exceeded LOAEL-based benchmarks. Therefore, the potential for ecological risk at the Eastern Undeveloped Area is expected to be minimal.

6.1.6 North-Central Undeveloped Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the North-Central Undeveloped Area.

6.1.6.1 Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil within the North-Central Undeveloped Area indicates negligible potential for adverse ecological effects associated with select metals. Maximum concentrations of soil COPECs were less than soil invertebrate available LOECs (**Table 6-10**). Maximum concentrations exceeded soil invertebrate NOECs for arsenic (HQ_{NOEC} = 2.3), barium (HQ_{NOEC} = 1.5), and manganese (HQ_{NOEC} = 5.8; **Table 6-10**). Based on refined EPCs, metal COPEC concentrations were below soil invertebrate NOEC values, except for barium (HQ_{LOEC} = 2.5).

For terrestrial plants, maximum concentrations of soil COPECs were lower than available LOECs, except for a minor barium exceedance (HQ_{LOEC} = 1.9; **Table 6-10**). Maximum concentrations exceeded terrestrial plant NOECs for three metals, with HQ_{NOEC} values ranging from 3.8 for thallium to 11.9 for manganese (**Table 6-10**). Refined EPCs were below terrestrial plant LOECs, except for a slight exceedance for barium (HQ_{LOEC} = 1.1 **Table 6-10**).

Figure 6-11 illustrates the spatial distribution of sampling stations within the North-Central Undeveloped Area that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Exceedances of soil invertebrate or terrestrial plant LOECs are limited to barium and manganese. Manganese concentrations were determined to be comparable to background concentrations in hypothesis testing between the approximate portion of the site encompassed by the North-Central Undeveloped Area and background sampling area SO#1 (Roux, 2019). Exceedances of barium on the eastern boundary of the North-Central Undeveloped Area were less than the BTV calculated for barium (774 mg/kg) for background soil area SO#4 that is typical of the Revett Formation soil type at the base of Teakettle Mountain (Roux, 2019). Barium exceedances to the west of the Cedar Creek Reservoir Overflow Ditch (**Figure 6-11**) are generally comparable to BTV for barium (300 mg/kg) calculated for the background soil area SO#1. These findings indicate that direct contact exposure to barium and manganese are consistent with background exposure in the North-Central Undeveloped Area.

6.1.6.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to soil in the North-Central Undeveloped Area and used maximum concentrations as the EPCs resulted in HQ_{NOAEL} values exceeding 1 for cyanide (American woodcock, mourning dove, and yellow-billed cuckoo) and BEHP (American woodcock, yellow-billed cuckoo) (**Table 6-57**). However, no HQ_{NOAEL} values exceeded 5, and no HQ_{LOAEL} values exceeded 1 (**Appendix H**).

The refined food chain model using more representative exposure assumptions resulted in HMW PAHs having an HQ greater than 1 for the mourning dove (1.5; **Tables 6-11 and 6-58**). All HQ_{LOAEL} values were less than 1. Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the North-Central Undeveloped Area, the dose associated with PAHs in soil associated with risk to the mourning dove does not originate from the North-Central Undeveloped Area, as all HQs are below 1 for these constituents when only doses from the target exposure area are considered (**Table 6-59**). Therefore, no constituents in soil at the North-Central Undeveloped Area represent a significant risk to ecological receptors due to exposure from direct and indirect ingestion pathways.

The results of the small range receptor evaluation for the North-Central Undeveloped Area are presented in **Figure 6-12**. All soil sample locations in this exposure area were below NOAEL-based benchmarks for small range receptors. It is noted that this ecological exposure area includes the sample locations around the periphery of the Industrial Landfill exposure area, indicating that the soil surrounding the landfill does not pose a threat to small range mammalian receptors.

6.1.6.3 Risk Characterization

Risk estimates for the North-Central Undeveloped Area indicate minimal potential for adverse effects associated with exposure to soil. Negligible risks to soil invertebrates and terrestrial plant communities above background risk are expected in the North-Central Undeveloped Area. Maximum concentrations for all constituents were below LOEC benchmarks for invertebrates, and refined EPCs for barium and manganese, which were detected at concentrations comparable to background, only marginally exceeded NOEC and LOEC benchmarks for plants. The wildlife ingestion model indicated that all HQ_{NOAEL} and HQ_{LOAEL} values were less than 1 for all receptors when only contributions from the North-Central Undeveloped Area were included in the risk estimates, and the small-range receptor evaluation did not identify any sample locations that exceeded LOAEL-based benchmarks. Therefore, the potential for ecological risk at the North-Central Undeveloped Area is expected to be minimal.

6.1.7 Western Undeveloped Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the Western Undeveloped Area.

6.1.7.1 Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil within the Western Undeveloped Area indicates negligible potential for adverse ecological effects associated with select metals. Maximum concentrations of soil COPECs were less than available soil invertebrate LOECs available for COPECs (**Table 6-12**). Maximum concentrations exceeded soil invertebrate NOECs for four metals, with HQ_{NOEC} values ranging from 1.6 (barium) to 4.9 (manganese; **Table 6-12**). Based on refined EPCs, metal COPEC concentrations were below soil invertebrate NOEC values, except for manganese (HQ_{LOEC} = 1.4).

For terrestrial plants, maximum concentrations of soil COPECs were lower than available LOECs, except for barium (HQ_{LOEC} = 2.1) and manganese (HQ_{LOEC} = 2.0; **Table 6-12**). Maximum concentrations exceeded terrestrial plant NOECs for four metals, with HQ_{NOEC} values ranging from 1.5 for zinc to 10.0 for manganese (**Table 6-12**). Refined EPCs were below terrestrial plant LOECs, except for a slight exceedance for barium (HQ_{LOEC} = 1.2).

Figure 6-13 illustrates the spatial distribution of sampling stations within the Western Undeveloped Area that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Exceedances of soil invertebrate or terrestrial plant LOECs are limited to barium and manganese. Manganese concentrations were determined to be comparable to background concentrations in hypothesis testing between the approximate portion of the site encompassed by the Western Undeveloped Area and background sampling area SO#1 (Roux, 2019). Barium concentrations that exceeded LOECs ranged from below to within two times the BTV (300 mg/kg) calculated for the background soil area SO#1 (**Figure 6-13**). These findings indicate that direct contact exposure to barium and manganese do not represent a substantial incremental risk above background risk.

6.1.7.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to soil in the Western Undeveloped Area and used maximum concentrations as the EPCs resulted in HQ_{NOAEL} values exceeding 1 for four receptors (**Table 6-57**). However, all values were less than 5, and no HQ_{LOAEL} values exceeded 1 (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in two constituents having an HQ greater than 1, including HMW PAHs for the mourning dove (HQ_{NOAEL} =1.5) and dioxins/furans for the short-tailed shrew (HQ_{NOAEL} =1.1); **Tables 6-13 and 6-58**). No HQ_{LOAEL} values exceeded 1.

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the Western Undeveloped Area, the dose associated with PAHs in soil associated with risk to the mourning dove does not originate from the Western Undeveloped Area, as all HQs are below 1 for these constituents when only doses from the target exposure area are considered (**Table 6-59**). The risk to the shrew associated with dioxin/furans does originate from the Western Undeveloped Area. However, because the HQs are so low (equal to or below 1, when rounded, for both the HQ_{NOAEL} and HQ_{LOAEL}), the risk associated with dioxins in soil is considered minimal. Therefore, no constituents in soil at the Western Undeveloped Area represent a significant risk to ecological receptors due to exposure from direct and indirect ingestion pathways.

The results of the small range receptor evaluation for the Western Undeveloped Area are presented in **Figure 6-14**. With the exception of one sample location (CFSB-216) that had concentrations exceeding the NOAEL-based benchmark for the short-tailed shrew for $TEC_{2,3,7,8\text{-}TCDD}$, all soil sample locations in this exposure area were below NOAEL-based benchmarks for small range receptors.

6.1.7.3 Risk Characterization

Risk estimates for the Western Undeveloped Area indicate minimal potential for adverse effects associated with exposure to soil. Negligible risks above background risks are expected for soil invertebrates and terrestrial plant communities in the Western Undeveloped Area. Refined risk estimates only slightly exceeded the NOEC for manganese for soil invertebrates (HQ = 1.4) and barium (HQ = 2.8) and manganese (HQ = 2.8) for terrestrial plants **Table 6-12**).Maximum concentrations for all constituents were below LOEC benchmarks for invertebrates, and refined EPCs for barium and manganese only marginally exceeded LOEC benchmarks for plants. Manganese and barium concentrations were generally comparable to background concentrations, indicating that incremental risk above background is not substantial. The wildlife ingestion model indicated that all HQ_{NOAEL} and HQ_{LOAEL} values attributable to the exposure area were equal to or less than 1 for all receptors when rounded and the small-range receptor evaluation did not identify any sample locations that exceeded LOAEL-based benchmarks. Therefore, the potential for ecological risk at the Western Undeveloped Area is expected to be minimal.

6.1.8 Flathead River Riparian Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial exposure in the Flathead River Riparian Area.

6.1.8.1 Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil within the Flathead River Riparian Area indicates negligible potential for adverse ecological effects. Maximum concentrations of soil COPECs were less than soil invertebrate ESVs for all COPECs. The maximum arsenic concentration was the only COPEC concentration to exceed soil invertebrate NOECs (HQ_{NOEC} = 1.2; **Table 6-14**). Based on refined EPCs, metal COPEC concentrations were below soil invertebrate NOEC values.

For terrestrial plants, maximum concentrations of soil COPECs were less than LOECs for COPECs, except for minor exceedances of barium (HQ_{NOEC} = 1.4) and manganese (HQ_{NOEC} = 1.6). Maximum concentrations exceeded terrestrial plant NOECs for barium (HQ_{NOEC} = 2.1) and manganese (HQ_{NOEC} = 2.1). Refined EPCs exceeded terrestrial plant NOECs for barium (HQ_{NOEC} = 1.4) and manganese (HQ_{NOEC} = 1.6); refined EPCs were below terrestrial plant LOECs (**Table 6-14**).

Figure 6-15 illustrates the spatial distribution of sampling stations within the Flathead River Riparian Area that exceed direct contact NOECs for soil invertebrate or terrestrial plant communities. As described above, soil concentrations were below available LOECs for terrestrial plants and soil invertebrates. Arsenic and manganese slightly exceeded soil invertebrate NOECs at stations CFSB-142 and CFSB-141, respectively. Exceedances at remaining stations are associated with concentrations exceeding terrestrial plant NOECs for barium or manganese, which are comparable to background soil concentrations. Manganese concentrations were determined to be comparable to background concentrations in hypothesis testing between the approximate portion of the site encompassed by the Flathead River Riparian Area and background sampling areas SO#2 and SO#3 (Roux, 2019). The maximum barium concentration in soil in the Flathead River Riparian Area (236 mg/kg) is below the BTV calculated for similar alluvial deposit background soil areas SO#2 and SO#3 (300 mg/kg; Roux, 2019). These findings indicate that direct contact exposure to barium and manganese do not represent a substantial incremental risk above background risk.

6.1.8.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to media in the Flathead River Riparian Area and used maximum concentrations as the EPCs resulted in HQ_{NOAEL} values exceeding 1 for three receptors due to exposure to cyanide (**Table 6-57**). However, all values were less than 5, and no HQ_{LOAEL} values exceeded 1 (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in one exceedance associated with the exposure of the mourning dove to HMW PAHs (HQ_{NOAEL} = 1.5; **Table 6-15 and 6-58**). However, exposure to HMW PAHs is not originating from the Flathead River Riparian Area, as the HQs for these PAHs were below 1 in the screening-level iteration of the food chain models (**Table 6-57)** and the refined exposure area-specific evaluation (**Table 6-59**) which assume 100 percent exposure to the target exposure area. Therefore, COPECs in soil at the Flathead River Riparian Area do not represent a significant risk to ecological receptors due to exposure from direct and indirect ingestion pathways.

The results of the small range receptor evaluation for the Flathead River Riparian Area are presented in **Figure 6-16**. All soil sample locations in this exposure area were below NOAEL benchmarks for small range receptors.

6.1.8.3 Risk Characterization

Risk estimates for the Flathead River Riparian Area indicate minimal potential for adverse effects associated with exposure to soil. Negligible risks to soil invertebrates and terrestrial plant communities are expected in the Flathead River Riparian Area. Refined risk estimates were below direct contact NOECs for soil invertebrates and slightly exceeded NOECs for barium (HQ = 1.4) and manganese (HQ = 1.6). Maximum concentrations for all constituents were below LOEC benchmarks for both soil invertebrates and terrestrial plants. The wildlife ingestion model indicated that all exposure area-specific HQ_{NOAEL} values were less than 1 for all receptors, and the small-range receptor evaluation did not identify any sample locations that exceeded NOAEL- or LOAEL-based benchmarks. Therefore, the potential for ecological risk at the Flathead River Riparian Area is expected to be minimal.

6.2 Transitional Exposure Areas

Risk estimates and baseline risk characterizations for direct contact and ingestion exposure pathways are presented below for transitional exposure areas. Given the seasonably variable hydrology of transitional exposure areas, direct contact exposure is evaluated for terrestrial receptors based on exposure to soil and for aquatic receptors based on exposure to sediment and surface water.

6.2.1 North Percolation Pond Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial and aquatic exposure scenarios in the North Percolation Pond Area.

6.2.1.1 Terrestrial Direct Contact Risk Estimate

The evaluation of direct contact pathways for terrestrial plants and soil invertebrates exposed to soil under dry conditions in the North Percolation Pond indicates the potential for adverse ecological effects, primarily associate with cyanide, metals, and PAHs. Maximum concentrations exceeded soil invertebrate NOECs for several metals, with HQ_{NOEC} values ranging from 2.4 (mercury) to 7.3 (zinc); maximum metal concentrations were lower than available LOECs for soil invertebrates (**Table 6-16**). Maximum concentrations of LMW PAHs (HQ_{NOEC} = 307 to 311) and HMW PAHs (HQ_{NOEC} = 763) exceeded NOECs for soil invertebrates (**Table 6-16**). Based on refined EPCs, concentrations of four metal COPECs exceeded soil invertebrate NOECs with HQ_{NOEC} values ranging from 1.3 (nickel and mercury) to 2.9 (zinc); refined EPCs were lower than soil invertebrate NOECs for metals. Refined risk estimates for LMW PAHs and HMW PAHs resulted in HQ_{NOEC} = 128 to 129 and HQ_{NOEC} = 318 to 463, respectively (**Table 6-16**); soil invertebrate LOECs for LMW and HMW PAHs were not identified.

For terrestrial plants, risk estimates indicate greatest exposure to cyanide and several metals. Maximum cyanide concentrations exceeded NOEC (HQ_{NOEC} = 21.4) and LOEC (HQ_{LOEC} = 6.4) values (**Table 6-16**). Maximum concentrations of several metals exceeded terrestrial plant NOECs, with HQ_{NOEC} values ranging from 1.2. (copper) to 92 (thallium); maximum metal concentrations exceeded terrestrial plant LOECs for six metals, with HQ_{LOEC} values ranging from 1.1 (zinc) to 9.2 (thallium; **Table 6-16**). Refined concentrations of nickel (HQ_{LOEC} = 1.3), thallium (HQ_{LOEC} = 3.8), and vanadium (HQ_{LOEC} = 1.4) exceeded terrestrial plant LOECs.

Figure 6-17 illustrates the spatial distribution of sampling stations within the North Percolation Pond that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Exceedances of metal LOECs are generally concentrated in the North-East Pond near the inflow and the channel; only barium exceeded a LOEC (terrestrial plants) in the North-West Pond (**Figure 6-17**). LMW and HMW PAH exceedances of soil invertebrate NOECs follow a similar spatial pattern, with greater concentrations in the North-East Pond and channel and lower concentrations in the North-West Pond.

6.2.1.2 Aquatic Direct Contact Risk Estimate

There is a potential for adverse effects to temporary aquatic communities that may be exposed primarily to cyanide, PAHs, and metals during inundated conditions in the North Percolation Pond. Maximum cyanide concentrations in sediment exceeded the benthic invertebrate LOEC (HQ_{LOEC} = 137; **Table 6-17**). Maximum metal concentrations exceeded LOECs for benthic invertebrates, with HQ_{LOEC} values ranging from 1.2 (selenium) to 26 (nickel; **Table 6-17**). Concentrations of LMW and HMW PAHs in sediment resulted in ∑ESBTU values exceeding 1, ranging from a maximum of 72.3 based on analyses of 13 PAH compounds (∑ESBTU13) and 199 based on estimated total exposure to 34 PAHs (∑ESBTU34;

Table 6-17). Based on refined EPCs, concentrations of cyanide (HQ_{LOEC} = 41.2) and nickel (HQ_{LOEC} = 7.5) exceed the benthic invertebrate LOEC; several metal COPECs exceeded benthic invertebrate NOECs based on refined concentrations with HQ_{NOEC} values ranging from 1.4 (arsenic and copper) to 16.4 (nickel).

Direct contact exposure to cyanide, fluoride, metals, and PAHs in surface water has the potential for adverse effects to temporary aquatic receptors that may be present under inundated conditions. Maximum fluoride concentrations exceeded LOECs for benthic invertebrates (HQ_{LOEC}=5.2 to 5.5) and amphibians (HQ_{LOEC}=3.6 to 3.7). Unfiltered and filtered aluminum, cadmium, and copper concentrations exceed sample-specific LOECs (**Table 6-19**). The maximum unfiltered barium concentration exceeded the LOEC (HQ_{LOEC}=6.0; **Table 6-18**). The maximum total cyanide concentration exceeded the chronic NOEC protective of invertebrates, aquatic plants, and amphibians (**Table 6-18**). Unfiltered lead and nickel concentrations exceeded NOECs but were less than sample-specific LOECs (**Table 6-19**). Concentrations of several PAH compounds exceeded benchmarks protective of invertebrates, aquatic plants, and amphibians, resulting in HQ_{NOEC} values ranging from 1.3 to 14.8 (**Table 6-18**).

Figure 6-18 illustrates the spatial distribution of sediment sampling stations within the North Percolation Pond that exceed direct contact NOECs or LOECs for benthic invertebrates; the spatial distribution of surface water sampling stations that exceed direct contact NOECs or LOECs for aquatic receptors is presented in **Figure 6-19**. Maximum concentrations of cyanide, PAHs, and several metals were observed in sediment samples from the North-East Pond and channel. Concentrations of these COPECs are lower in the North-West Pond; however, cyanide and nickel exceed benthic invertebrate LOECs at each sampling location in the North-West Pond. Only two surface water samples were collected from the North Percolation Pond. Maximum concentrations of fluoride and most metals were observed in sample CFSWP-024 collected in the North-East Pond (**Figure 6-19**).

6.2.1.3 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to media in the North Percolation Pond Area and used maximum concentrations as the EPCs resulted in HQs exceeding 1 for every receptor except the mink (**Table 6-57**). Exposure to nickel, vanadium, cyanide, and especially PAHs, which had HQs exceeding 1,000 for some receptors, resulted in the highest HQs within this exposure area (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in several constituents having an HQ greater than 1. Several metals had HQ_{LOAEL} values greater than 1 for multiple receptors, including nickel (American woodcock and short-tailed shrew), selenium (American dipper), and vanadium (American dipper). Ingestion of PAHs resulted in highly elevated HQs in the refined assumption, with LMW PAHs exceeding HQ_{NOAEL} values of 100 for the American dipper and 10 for the American woodcock, belted kingfisher, and yellow-billed cuckoo. HMW PAHs had HQ_{NOAEL} values greater than 1,000 for the American dipper, American woodcock, and short-tailed shrew, and greater than 100 for the belted kingfisher, yellow-billed cuckoo, and meadow vole. HQ_{LOAEL} values for HMW PAHs were also highly elevated, with the American dipper greater than 100 (HQ_{LOAEL}=284), and the American woodcock (HQ_{LOAEL}=103), belted kingfisher (HQ_{LOAEL}=27), yellow-billed cuckoo (HQ_{LOAEL}=29), and short-tailed shrew (HQ_{LOAEL}=23) all having HQ_{LOAEL} values greater than 10 (**Table 6-20**). Nearly all of the risk was associated with the ingestion of terrestrial and aquatic invertebrates for all constituent-receptor combinations, with 93 to 99 percent (depending on the receptor) of the total dose affiliated with this pathway.

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the North Percolation Pond, the dose associated with all constituents associated with elevated HQs as described in the previous paragraph originate primarily from the North Percolation Ponds Area (**Table 6-59**). Furthermore, none of these constituents were determined to be background-related in the background hypothesis testing evaluation at this exposure area (Roux, 2019). Therefore, nickel and vanadium, which had HQ_{LOAEL} values between 1 and 10 for at least one receptor, are considered to be of moderate concern for ecological receptors. Constituents with HQ_{LOAEL} values between 10 and 100 for at least one receptor, including LMW PAHs, are considered to be of high concern. Finally, HMW PAHs, which had HQ_{LOAEL} values greater than 100 for multiple receptors (American dipper and American woodcock) are considered to be of greatest concern in soil at the North Percolation Pond Area due to exposure via direct and indirect ingestion routes.

The results of the small range receptor evaluation for the North Percolation Pond Area are presented in **Figure 6-20**. Two of the eight sample locations in the former North-West Percolation Pond had concentrations that exceeded the LOAEL for short-tailed shrew based primarily on exceedances of LMW and HMW PAHs and nickel. Six of the eight locations in the North-East Percolation Pond had concentrations that exceeded the LOAEL-based benchmarks for one or both receptors. Additionally, all six sample locations in the overflow ditch connecting the two ponds had concentrations exceeding the LOAEL-based benchmark for at least one receptor, and two stations (CFSB-272 and CFSB-203) exceeded the LOAEL-based benchmark for both receptors. No sample location in this exposure area had soil concentrations that were below NOAEL-based benchmarks for both receptors.

6.2.1.4 Risk Characterization

Risk estimates for the North Percolation Pond Area indicate that the greatest potential for adverse direct contact effects is associated with exposure to cyanide, fluoride, metals, and PAHs during inundated conditions in the North-East Pond. Under inundated conditions, maximum concentrations of fluoride, aluminum, barium, cadmium, copper, and zinc in surface water exceeded LOEC benchmarks protective of aquatic communities, and 7 PAH compounds exceeded NOEC benchmarks (LOEC values were not available). In sediment, PAH ESBTUs were greater than 1 at 24 stations and greater than 10 at 13 stations. Several inorganics in sediment, including metals and cyanide, also exceeded their LOEC values. Under dry scenarios, exposure to PAHs in soil also resulted in very high exceedances of NOEC values protective of soil invertebrates. However, refined EPCs for other constituents did not exceed LOEC values. Seven metals did, however, exceed LOECs protective of plants when their maximum concentrations were considered, but the refined EPCs for only nickel, thallium, and vanadium exceeded plant-based LOECs, and all resulted in HQs below 5 (PAH impacts to plants are uncertain due to a lack of NOEC/LOEC values for these receptors).

Elevated risks associated with direct and indirect ingestion by wildlife receptors were also observed in North Percolation Pond based on the results of the food chain modeling. Several metals in soil/sediment had HQ_{LOAEL} values in the refined model greater than 1 for multiple receptors, including nickel (American woodcock and short-tailed shrew, and the yellow-billed cuckoo had an HQ_{NOAEL} that slightly exceeded 1 for this metal), selenium (American dipper), and vanadium (American dipper). Ingestion of PAHs resulted in highly elevated HQs even using the refined assumptions, with LMW PAHs exceeding HQ_{LOAEL} values of 10 for the American dipper and above 1 for the American woodcock and yellow-billed cuckoo. HQ_{LOAEL} values for HMW PAHS were even more highly elevated, with the American dipper greater than

100 (HQ_{LOAEL}=284), American woodcock (HQ_{LOAEL}=103), belted kingfisher (HQ_{LOAEL}=27), yellow-billed cuckoo (HQ_{LOAEL}=29), and short-tailed shrew (HQ_{LOAEL}=23) all having HQ_{LOAEL} values greater than 10. The ingestion of terrestrial and aquatic invertebrate prey items was the critical exposure pathway for all constituent/receptor combinations. The small range receptor evaluation indicated that every soil sampling point exceeded LOAEL-based benchmark values protective of these receptors.

The North Percolation Ponds represent low quality habitat for terrestrial or aquatic receptors, based on their use as a former wastewater management structure. Based on the degraded habitat function and value of the North Percolation Ponds, exposure pathways may be more limited than the exposure assumptions used in direct contact and ingestion pathway evaluations. However, based on the risk estimates presented in the BERA, exposure to waste related COPECs in multiple media in the North Percolation has the potential to adversely affect ecological receptors.

6.2.2 South Percolation Pond Area

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial and aquatic exposure scenarios in the South Percolation Pond Area. Given the seasonably variable hydrology of the ponds, exposure is evaluated for terrestrial receptors and aquatic receptors potentially exposed in the South Percolation Pond.

6.2.2.1 Terrestrial Direct Contact Risk Estimate

The evaluation of direct contact exposure pathways to soil indicates limited potential for adverse effects to soil invertebrate and terrestrial plant communities under dry conditions in the South Percolation Pond (**Table 6-21**). Maximum concentrations of copper (HQ_{LOEC}=1.3) and mercury (HQ_{LOEC}=2.8) exceeded LOEC values for soil invertebrates; however, refined concentrations of metals were lower than available LOECs (**Table 6-21**). Maximum concentrations of refined organic COPECs were comparable to or lower than available NOECs for soil invertebrates (**Table 6-21**).

For terrestrial plants, maximum COPEC concentrations were lower than LOECs for all COPECs, except for barium (HQ_{LOEC}=3.7) and copper (HQ_{LOEC}=1.4). Only the refined EPC for barium (HQ_{LOEC}=2.5) exceeded the LOEC for terrestrial plants.

Figure 6-21 illustrates the spatial distribution of sampling stations within the South Percolation Pond that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Exceedances of barium, copper, mercury were isolated to station CFSB-153 near the inflow; remaining stations exceeded the terrestrial plant LOEC for barium but were below the soil invertebrate LOEC.

6.2.2.2 Aquatic Direct Contact Risk Estimate

Direct contact risk estimates for aquatic receptors potentially inhabiting the South Percolation Ponds when aquatic habitat is present indicate potential sediment exposure to metals and potential aqueous exposure to cyanide (total and free) and select metals (**Table 6-22**). Maximum concentrations of total cyanide and five metals exceeded sediment LOECs for benthic invertebrates, resulting in HQ_{LOEC} values ranging from 1.1 (nickel) to 5.0 (copper). Based on refined concentrations, total cyanide (HQ_{LOEC}=4.4), barium (HQ_{LOEC}=2.1), and copper (HQ_{LOEC}=1.4) exceeded LOECs (**Table 6-22**).

The results of AVS-SEM and pore water analyses in sediment indicate metals are not bioavailable at concentrations likely to result in adverse effects to benthic invertebrates. The maximum organic carbon normalized difference between SEM and AVS [-24.4 micromoles per gram organic carbon (µmol/g_{OC})] is less than 130 µmol/g_{OC}, indicating that divalent metals (e.g., cadmium, copper, lead, nickel, silver, and zinc) are not likely bioavailable at concentrations associated with adverse effects to benthic invertebrate receptors. Consistent with the AVS-SEM results, concentrations of divalent metals in pore water samples were below LOEC values (**Table 6-23**). Sample-specific analysis of copper concentrations in pore water indicated concentrations below sample-specific NOECs (**Table 6-24**). Maximum concentrations of barium in pore water exceeded the LOEC value (HQ_{LOEC}=10.8).

LMW and HMW PAH concentrations in sediment resulted in ∑ESBTU values less than 1 based on estimated total exposure to 34 PAHs ($\sum ESBTU_{34}$; **Table 6-22**), indicating that PAH compounds are not bioavailable in sediment pore water at concentrations that would result in adverse effects to benthic invertebrate receptors. Consistent with the EqP results, the only PAHs detected in pore water were phenanthrene (5 samples) and naphthalene (1 sample). Concentrations of both compounds were below FCVs protective of benthic and aquatic receptors.

Direct contact aqueous risk estimates indicate the potential for adverse effects associated with exposure to total cyanide, aluminum (filtered and unfiltered), copper (filtered and unfiltered), and barium (**Table 6-25**). The maximum total cyanide concentration exceed the NOEC based on the criterion continuous concentration (CCC) (chronic) water quality criterion (HQ_{LOEC}=13.1 to 26.7) and the LOEC based on the criteria maximum concentration (CMC) (acute) water quality criterion (HQ_{LOEC}= 3.1 to 6.3); the refined total cyanide concentration exceeded the NOEC (HQ_{NOEC}=10.2) and LOEC (HQ_{LOEC}= 2.4). However, free cyanide concentrations were below LOECs and only slightly exceeded NOECs based on the maximum (HQ_{LOEC}= 1.9) and refined concentrations (HQ_{LOEC}= 1.1). Aluminum (unfiltered or filtered) concentrations exceeded NOECs in 6 of 26 samples, with HQ_{NOEC} values ranging from 1.2 to 37.1; aluminum (unfiltered or filtered) concentrations exceeded LOECs in 2 of 26 samples, with HQ_{LOEC} values ranging from 1.0 to 11.7 (**Table 6-26**). Copper concentrations marginally exceeded samples-specific NOECs in 1 of 17 filtered (HQ_{NOEC}=1.9) and 3 of 26 unfiltered samples (HQ_{NOEC}=1.1 to 1.5). The sample-specific LOEC was slightly exceeded in one sample in the filtered (HQ_{LOEC}=1.2) and unfiltered (HQ_{LOEC}=1.1) fractions (**Table 6-26**). Maximum and refined concentrations of barium (unfiltered and filtered) exceeded LOECs, with HQ_{LOEC} values for maximum and refined concentrations in filtered samples ranging from 13.5 to 8.0, respectively (**Table 6-25**).

Figure 6-22 illustrates the spatial distribution of sediment and pore water sampling stations within the South Percolation Pond that exceed direct contact NOECs or LOECs for benthic invertebrates; the spatial distribution of surface water sampling stations that exceed direct contact NOECs or LOECs for aquatic receptors is presented in **Figure 6-23**. Exceedances of cyanide and multiple metals, including, barium, copper, mercury, nickel, and silver were associated with station CFSB-153 near the inflow; remaining stations exceeded the LOECs, primarily for barium or cyanide in surface water or pore water (**Figure 6-22**). Surface water exceedances were generally consistent spatially within sampling events; however, exceedances were greatest during the November 2017 Supplemental South Pond Assessment sampling event.

6.2.2.3 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to media in the South Percolation Pond Area and used maximum concentrations as the EPCs resulted in HQs exceeding 1 for multiple receptors (**Table 6-57**). Exposure to copper and BEHP resulted in the highest HQs within this exposure area (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in several constituents having an HQ greater than 1. Barium was the only constituent with an HQ_{LOAEL} value greater than 1 (American dipper HQ_{LOAEL}=2.3). Cadmium, copper, vanadium, HMW PAHs, and BEHP all had HQ_{NOAEL} values greater than 1 for one or more receptors, but all were relatively low, and none had HQ_{LOAEL} values greater than 1 (**Tables 6-27 and 6-58**). Also, vanadium concentrations were determined to be comparable to background concentrations in hypothesis testing between the approximate portion of the site encompassed by the South Percolation Pond Area and background sampling area SO#2 and SO#3 (Roux, 2019). The yellow-billed cuckoo, which is evaluated using NOAEL endpoints, had HQ_{NOAEL} values that exceeded 1 for HMW PAHs (HQ = 3.9) and BEHP (HQ = 2.8).

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the South Percolation Pond, the dose associated with barium for the American dipper is associated primarily with the target exposure area (**Table 6-59**). The refined EPC for barium of 640 mg/kg in sediment is approximately double the soil BTV for SO#2 and SO#3 (300 mg/kg; Roux, 2019). However, because of the low HQs observed under maximum and refined assumptions, barium is considered to be of low concern from direct and indirect ingestion pathways in the South Percolation Pond Area.

The results of the small range receptor evaluation for the South Percolation Pond Area are presented in **Figure 6-24**. This exposure area contained a mixture of sample locations that were below NOAEL benchmarks for both receptors, and that exceeded NOAEL (but not LOAEL) benchmarks for the short-tailed shrew. No sample location in this exposure area had concentrations that exceeded LOAEL benchmarks for small range receptors.

6.2.2.4 Risk Characterization

During periods of inundation, exposure to cyanide and select metals in surface water has the greatest potential for adverse effects to temporary aquatic communities via direct contact exposure pathways. Based on MDEQ water quality criteria, cyanide exposure has the potential to adversely affect aquatic receptors due to concentrations exceeding chronic and acute criteria for total cyanide. However, there is a lower potential for adverse effects based on analyses of free cyanide, which is the bioavailable and potentially toxic form of cyanide and the basis for USEPA NRWQC. Concentrations of free cyanide were below the LOEC (NRWQC CMC) and only slightly exceeded the NOEC (NRWQC CCC). Aluminum concentrations were temporally variable in surface water, with maximum concentrations in unfiltered and filtered samples exceeding chronic and acute sample-specific criteria.

Potential direct contact aqueous exposure in the South Percolation Ponds is likely limited to tolerant receptors that can withstand the seasonal hydrology that controls habitat conditions. Because aquatic habitat is intermittent, the South Percolation Ponds do not likely support permanent communities of fish but may support tolerant invertebrates and seasonal use of aquatic habitat by amphibians and opportunistic species. The greatest risk via aqueous exposures to these receptors is likely associated with exposure to cyanide, aluminum, barium, and copper.

Risk estimates for COPECs in sediment during inundated conditions indicate limited potential for adverse effects to benthic invertebrates. The results of AVS-SEM and pore water analyses indicate that metals are not bioavailable at concentrations likely to result in adverse effects to benthic invertebrates. Further, $\sum ESBTU_{34}$ and direct pore water analyses indicate that PAH compounds are not bioavailable in concentrations associated with adverse effects to benthic invertebrate receptors. Exposure to cyanide in sediment is likely associated with aqueous phase concentrations in surface water and pore water. During dry periods, negligible risk is expected to terrestrial invertebrate and plant communities, as maximum and refined EPCs only marginally exceeded LOEC values for a few metals (barium, copper, and mercury).

Risk associated with direct and indirect ingestion by wildlife receptors in South Percolation Pond media is minimal based on the results of the food chain modeling. Barium in soil/sediment had an HQ_{LOAEL} value that was slightly greater than 1 for the American dipper. The refined EPC for barium of 640 mg/kg in sediment is approximately double the soil BTV for SO#2 and SO#3 of 300 mg/kg. However, because of the low HQs observed under maximum and refined assumptions, barium is of low concern from direct and indirect ingestion pathways in the South Percolation Pond Area. Furthermore, no sample location in this exposure area had concentrations that exceeded LOAEL benchmarks for small range receptors.

Although the yellow-billed cuckoo is evaluated based on NOAEL endpoints due to its current status as a federally threatened species, the likelihood of adverse effects resulting from exposure to HMW PAHs or BEHP is low. The yellow-billed cuckoo had HQ_{NOAEL} values using the spatially weighted ingestion model that exceeded 1 for HMW PAHs (3.9) and BEHP (2.8; **Table 6-58**), and exposure to these constituents was associated with the South Percolation Pond exposure area (**Table 6-59**). BEHP is a common laboratory contaminant and is unlikely to be related to site operations. HMW PAHs are associated with site operations. However, as previously discussed (see **Section 6.1.1.3**), there is a low probability of occurrence of yellow-billed cuckoo at the Site and the doses exceeding NOAEL TRVs likely overestimate risk due to the conservative estimate of dietary COPEC concentrations based on 100 percent ingestion of earthworms.

6.2.3 Cedar Creek Reservoir Overflow Ditch

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial and aquatic exposure scenarios in the Cedar Creek Reservoir Overflow Ditch. Given the seasonably variable hydrology of the ponds, exposure is evaluated for terrestrial receptors and aquatic receptors potentially exposed in the Cedar Creek Reservoir Overflow Ditch.

6.2.3.1 Terrestrial Direct Contact Risk Estimate

The evaluation of direct contact exposure pathways to soil indicates negligible potential for adverse effects to soil invertebrate and terrestrial plant communities under dry conditions in the Cedar Creek Reservoir Overflow Ditch (**Table 6-28**). Maximum concentrations of metals and HMW PAHs were below LOECs for soil invertebrates and only maximum concentrations of arsenic (HQ_{LOEC}=1.1), manganese (HQ_{LOEC}=3.6), and zinc (HQ_{LOEC}=1.1) exceeded soil invertebrate NOECs. Refined concentrations of metals were less than NOECs for all metals except manganese (HQ_{NOEC}=3.0).

For terrestrial plants, maximum concentrations of metals and di-n-butyl phthalate were below LOECs, except for slight exceedances of maximum concentrations of barium (HQ_{LOEC}=1.1) and manganese (HQ_{LOEC}=1.5). Refined concentrations of barium (HQ_{LOEC}=1.1) and manganese (HQ_{LOEC}=1.2) also slightly exceeded terrestrial plant LOECs (**Table 6-28**).

Figure 6-25 illustrates the spatial distribution of sampling stations within the Cedar Creek Reservoir Overflow Ditch that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Exceedances of LOECs were limited to barium and manganese. Manganese concentrations are generally consistent from upgradient (CFSDP-013) to downgradient stations, indicating that concentrations of manganese in the Cedar Creek Reservoir Overflow Ditch may be related to regional soil conditions and not site-related operations and pathways; concentrations of barium were also consistent from the most upgradient to downgradient sample, indicating limited site-related influence (**Figure 6-25**). Further, maximum concentrations of manganese (1,640 mg/kg) and barium (295 mg/kg) in the Cedar Creek Reservoir Overflow Ditch were comparable to or lower than BTV values calculated for the Revett Formation background soil type (SO#4) (1,566 mg/kg and 734 mg/kg for manganese and barium, respectively) that was sampled to reflect soil conditions near the base of Teakettle Mountain (Roux, 2019). These findings indicate that direct contact exposure to barium and manganese do not represent a substantial incremental risk above background risk.

6.2.3.2 Aquatic Direct Contact Risk Estimate

Direct contact risk estimates for aquatic receptors potentially inhabiting the Cedar Creek Overflow Ditch when aquatic habitat is present indicate limited potential for adverse effects for benthic invertebrates exposed to metals and PAHs in sediment, and aqueous exposure to free cyanide and select metals. Maximum concentrations of cyanide (HQ_{LOEC}=1.5) and manganese (HQ_{LOEC}=1.5) only slightly exceeded LOECs for benthic invertebrates; only the refined manganese concentration exceeded the LOEC (HQ_{LOEC}=1.2; **Table 6-29**). For PAHs, ∑ESBTU values were less than 1.0 for all stations except CFSB-284 ($\sum ESBTU_{13}$ = 7.7; $\sum ESBTU_{34}$ = 21.2). Elevated ∑ESBTU values at this station were attributed to low organic carbon concentrations (0.006 percent) and relatively low total PAH concentrations (7.4 mg tPAH/kg).

Direct contact aqueous risk estimates indicate negligible potential for adverse effects associated with exposure to free cyanide and select metals (**Table 6-30**). The maximum free cyanide concentration was comparable to the NOEC for aquatic receptors (HQ_{NOEC}=1.1) but was lower than the LOEC. Unfiltered aluminum concentrations exceeded sample-specific NOECs in 2 of 27 samples, with HQ_{NOEC} values ranging from 1.9 to 10.3. Unfiltered aluminum concentrations exceeded sample-specific LOECs in 1 of 27 samples (HQ_{LOEC}=6.5; **Table 6-31**). Filtered aluminum concentrations were below NOECs. Maximum and refined concentrations of barium (unfiltered and filtered) exceeded LOECs, with HQ_{LOEC} values for maximum and refined concentrations in filtered samples ranging from 5.4 to 5.6 and 2.6 to 2.7, respectively (**Table 6-30**). The maximum concentration of manganese slightly exceeded the LOEC (HQ_{LOEC}=1.6), but the refined concentration was less than the NOEC and LOEC (**Table 6-30**).

Figure 6-26 illustrates the spatial distribution of sediment and pore water sampling stations within the Cedar Creek Reservoir Overflow Ditch that exceed direct contact NOECs or LOECs for benthic invertebrates; the spatial distribution of surface water sampling stations that exceed direct contact NOECs or LOECs for aquatic receptors is presented in **Figure 6-27**. Sediment exceedances of manganese were identified at four stations; however, as stated in the previous section, manganese concentrations in the Cedar Creek Reservoir Overflow Ditch are consistent upgradient to downgradient within the ditch and also to concentrations observed in the SO#4 background dataset. The only PAH exceedance observed at CFSB-284 was attributed to low organic carbon concentrations (0.006 percent) and relatively low total PAH concentrations (7.4 mg tPAH/kg). Barium concentrations in surface water samples were consistent upgradient to downgradient and during the June 2018 sampling event. The maximum barium concentration was observed at downgradient station (CFSWP-039) during the October 2018 sampling event; however, there are no other stations for comparison during that sampling event. These findings indicate that direct contact exposure within the Cedar Creek Reservoir Overflow Ditch are consistent with regional conditions and not associated with site-related pathways.

6.2.3.3 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to media in the Cedar Creek Reservoir Overflow Ditch Area and used maximum concentrations as the EPCs resulted in HQs for arsenic, nickel, selenium, vanadium, zinc, and HMW PAHs exceeding 1 for three different receptors (**Table 6-57**). However, all HQs were below 5 (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in several constituents having an HQ greater than 1, but only copper (American woodcock and yellow-billed cuckoo), Aroclor 1254 (American woodcock and yellow-billed cuckoo), and HMW PAHs (yellow-billed cuckoo) had HQ_{LOAEL} values that exceeded 1 (**Table 6-32**). All HQ_{LOAEL} values were less than 5. The yellow-billed cuckoo, which is evaluated using NOAEL endpoints, also had HQ_{NOAEL} values that slightly exceeded 1 for LMW PAHs, BEHP, and dioxins/furans.

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the Cedar Creek Reservoir Overflow Ditch Area, none of the constituents resulting in elevated HQs were directly related to this exposure area. Because the area being assessed is a thin, linear polygon, it is strongly influenced by adjacent exposure areas for the cumulative risk calculated for most receptors. When only exposure to the Cedar Creek Overflow Ditch exposure is considered, only HQ_{NOAEL} values for barium (American dipper = 1.8), nickel (short-tailed shrew = 2), vanadium (American dipper = 1.9), and HMW PAHs (American dipper = 2.3) slightly exceeded 1; all HQ_{LOAEL} values were below 1 (**Table 6-59**). Therefore, constituents in media associated with the Cedar Creek Reservoir Overflow Ditch Area are considered to be of low concern for ecological receptors.

The results of the small range receptor evaluation for the Cedar Creek Reservoir Overflow Ditch Area are presented in **Figure 6-28**. Seven of the eight soil sample locations along this exposure area had concentrations that exceeded the NOAEL (but not the LOAEL) for the shrew. The most downstream location in the ditch (CFSDP-009) did not have any exceedances of NOAEL benchmarks for either receptor.

6.2.3.4 Risk Characterization

During periods of inundation, direct contact risk associated with surface water and sediment is expected to be minimal. Some exceedances of NOEC and LOEC in both media were noted, but consideration of BTVs, concentration gradients, the low magnitude and frequency of exceedances, and other factors suggest that site-related toxicity related to these constituents is unlikely. For times of the year when inundation does not occur, direct contact risk to terrestrial organisms is expected to be negligible relative to background risk. No constituents had maximum concentrations that exceeded their LOECs for terrestrial invertebrates and plants, except for barium and manganese, which both had slight exceedances of LOECs protective of invertebrates. Refined risk estimates indicate minor exceedances of manganese NOECs for soil invertebrates and barium and manganese NOECs for terrestrial plants. However, maximum concentrations of manganese and barium approximate or are lower than their respective BTVs for the SO#4 reference area that was sampled to reflect soil conditions near the base of Teakettle Mountain (Roux, 2019).

The food chain modeling results for the Cedar Creek Reservoir Overflow Ditch resulted in HQ_{LOAEL} values that exceeded 1 for copper (American woodcock and yellow-billed cuckoo), Aroclor 1254 (American woodcock and yellow-billed cuckoo), and HMW PAHs (yellow-billed cuckoo). However, all HQ_{LOAEL} values were less than 5, and further evaluation indicated that adjacent exposure areas were responsible for nearly all of the doses resulting in these exceedances. The small-range receptor evaluation revealed that a single sample in this exposure area had concentrations that exceeded only the NOAEL benchmark, but no benchmarks based on LOAELs were exceeded in this exposure area. Therefore, no constituents in media associated with the Cedar Creek Reservoir Overflow Ditch Area are considered to be of concern for direct or indirect ingestion by wildlife receptors.

6.2.4 Northern Surface Water Feature

The following sections present the direct contact and ingestion risk estimates and the baseline ecological risk characterization for terrestrial and aquatic exposure scenarios in the Northern Surface Water Feature.

6.2.4.1 Terrestrial Direct Contact Risk Estimate

Risk estimates and risk characterization for direct contact exposure pathways are presented below for the Northern Surface Water Feature. The evaluation of direct contact exposure pathways to soil indicates negligible potential for adverse effects to soil invertebrate and terrestrial plant communities under dry conditions in the Northern Surface Water Feature (**Table 6-33**). Refined risk estimates slightly exceeded NOECs for soil invertebrates for arsenic, barium, and manganese (HQ = 1.8) and terrestrial plant NOECs for barium, manganese, and selenium (HQ = 2.2 to 5.3). Maximum concentrations of metals were below LOECs for soil invertebrates, with only limited exceedances of soil invertebrate NOECs (HQ_{NOEC}=1.1 to 2.7). For terrestrial plants, maximum concentrations of barium (HQ_{LOEC}=3.5) and selenium (HQ_{LOEC}=1.5) were the only COPECs to exceed LOECs for terrestrial plants; the refined barium concentration was the only COPEC to exceed the LOEC (HQ_{LOEC}=2.3; **Table 6-33**).

Figure 6-29 illustrates the spatial distribution of sampling stations within the Northern Surface Water Feature that exceed direct contact NOECs or LOECs for soil invertebrate or terrestrial plant communities. Barium concentrations exceeded the terrestrial plant LOEC at all but two stations within the Northern Surface water Feature; observed barium concentrations were 1- to 3-times the BTV (300 mg/kg) calculated for the background soil area SO#1 (**Figure 6-29**).

6.2.4.2 Aquatic Direct Contact Risk Estimate

Direct contact risk estimates for aquatic receptors potentially inhabiting the Northern Surface Water Feature when aquatic habitat is present indicate limited potential for adverse effects for benthic invertebrates exposed to metals in sediment and aqueous exposure to select metals. Maximum concentrations of barium (HQ_{LOEC}=3.0) and selenium (HQ_{LOEC}=1.5) were the only COPECs to exceed LOECs for benthic invertebrates; only the refined barium concentration exceeded the LOEC (HQ_{LOEC}=2.0; **Table 6-34**). For PAHs sediment, ∑ESBTU values were less than 1.0 for all stations, indicating negligible potential for adverse effects to benthic invertebrates exposed to PAHs in sediment. Sediment pore water samples collected at Northern Surface Water Feature stations indicate that barium is the only COPEC to exceed LOECs for aquatic receptors (**Table 6-35; Table 6-36**).

Direct contact aqueous risk estimates indicate limited potential for adverse effects associated with exposure to unfiltered aluminum and unfiltered and filtered barium (**Table 6-37**). Unfiltered aluminum concentrations exceeded sample-specific NOECs in 3 of 16 samples, with HQ_{NOEC} values ranging from 1.2 to 3.8. unfiltered aluminum concentrations exceeded sample-specific LOECs in 2 of 16 samples (HQ_{LOEC}=1.2 and 1.9; **Table 6-38**). Filtered aluminum concentrations were below NOECs. Maximum and refined concentrations of barium (unfiltered and filtered) exceeded LOECs, with HQ_{LOEC} values for maximum and refined concentrations in filtered samples ranging from 5.9 to 3.8, respectively (**Table 6-37**).

Figure 6-30 illustrates the spatial distribution of sediment and pore water sampling stations within the Northern Surface Water Feature that exceed direct contact NOECs or LOECs for benthic invertebrates. The spatial distribution of surface water sampling stations that exceed direct contact NOECs or LOECs for aquatic receptors is presented in **Figure 6-31**. LOECs exceedances in sediment/pore water are primarily associated with barium concentrations in pore water, which were greatest near the western edge of the feature (CFSDP-049). Surface water barium concentrations were generally consistent throughout the Northern Surface Water Feature, but similar to pore water, the greatest concentration was observed near station CFSDP-049. Except for stations near the western edge of the feature, barium concentrations in pore water and surface water are not substantially greater than the BTV calculated from upgradient filtered samples off-site in Cedar Creek (99.8 µg/L). These findings indicate that direct contact exposure to barium in pore water and surface water in the Northern Surface Water Feature does not represent a substantial incremental risk above background risk upstream of the Site in Cedar Creek.

6.2.4.3 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to media in the Northern Surface Water Feature Area and used maximum concentrations as the EPCs resulted in HQs exceeding 1 for barium, copper, selenium, and vanadium for several receptors (**Table 6-57**). Exposure to barium and selenium resulted in the highest HQs within this exposure area (**Appendix H**).

The refined food chain model using more realistic assumptions resulted in several metals having an HQ greater than 1, but only barium and selenium for the American dipper had HQ_{LOAEL} values that marginally exceeded 1 (**Tables 6-39 and 6-58**). The HQ_{LOAEL} values for both metals were less than 5. The critical pathway for these two metals was ingestion of invertebrates, which accounted for 99 percent of the dose of both barium and selenium. The results of the background hypothesis testing indicate that both metals were elevated relative to background soil concentrations in this area (Roux, 2019). However, the refined EPCs for barium (586 mg/kg) and selenium (1.62 mg/kg) in soil/sediment were not highly elevated compared to the BTVs in soil for these constituents in SO#1 (300 mg/kg and 1.4 mg/kg, respectively; Roux, 2019).

Because the refined evaluation considers cumulative doses across multiple exposure areas for large range receptors, it is helpful to also evaluate potential risk associated with an exposure area assuming that 100 percent of exposure originates in that area in order to understand contributions from the target area itself rather than adjacent areas. For the Northern Surface Water Feature, the dose associated with barium and selenium are associated primarily with the target exposure area (**Table 6-59**). However, because of the low HQs observed under maximum and refined assumptions, barium and selenium in Northern Surface Water Feature are considered to be of low concern due to direct and indirect ingestion pathways in this exposure area.

The results of the small range receptor evaluation for the Northern Surface Water Feature Area are presented in **Figure 6-32**. All eight of the soil sample locations in the southwestern portion of the site were below NOAEL benchmarks for both small range receptors. The two sample locations in the northeastern portion of this exposure area (CFSDP-046 and CFSDP-047) exceeded NOAEL-based soil benchmarks for selenium.

6.2.4.4 Risk Characterization

During periods of inundation, toxicity associated with direct contact with surface water and sediment is expected to be limited relative to background exposure. Refined risk estimates indicated surface water exceedances of NOECs for aluminum, barium, and iron. Maximum surface water concentrations of aluminum and barium exceeded LOECs; however, only barium had filtered refined concentrations that exceeded LOECs. The refined EPC for barium in surface water also exceeded its LOEC. Refined sediment risk estimates for total cyanide, barium, and selenium exceeded sediment NOECs; barium was also the only constituent with a refined EPC that exceeded its sediment LOEC protective of benthic invertebrates (HQ_{LOEC} = 2). However, barium exposure in the Northern Surface Water Feature is not substantially greater than background exposure upstream of the Site in Cedar Creek.

Potential direct contact aqueous exposure during periods of inundation in the Northern Surface Water Feature is likely limited to tolerant receptors that can withstand the seasonal hydrology that controls habitat conditions. Further, inundation in the Northern Surface Water Feature varies interannually. The feature was inundated when it was identified during a field visit in May 2016; however, the feature was dry during a field visit in May 2019. Because aquatic habitat is seasonal and varies interannually, the Northern Surface Water Feature does not support permanent communities of benthic invertebrates or fish, but may support temporary communities of tolerant invertebrates and seasonal use of aquatic habitat by amphibians and opportunistic species.

During dry periods, negligible risk is expected for soil invertebrates, as the maximum EPCs for all constituents were below LOECs protective of these organisms. Barium slightly exceeded its LOEC for the protection of terrestrial plants, but this exceedance was below 5.

For the wildlife ingestion model, only barium and selenium had HQ_{LOAEL} values that were greater than 1 (American dipper), but values for both of these metals were less than 5, and refined EPCs were not highly elevated compared to relevant BTVs. Ingestion of invertebrate prey items was the critical pathway for both metals. It should be noted that the higher HQs for the American dipper compared to other receptors was the result of the American dipper hypothetically ingesting benthic invertebrates that have body burdens modeled on uptake from sediment, rather than terrestrial invertebrates that have body burdens modeled on uptake from soil. The uptake factors for sediment to benthic invertebrates used in the food chain model resulted in estimated benthic invertebrate prey item concentrations that were 30-times and 5-times higher for barium and selenium, respectively, than for terrestrial invertebrate prey items that were assumed to be exposed to these metals in soil (**Appendix E**). The Northern Surface Water Feature is an intermittently wet area, and therefore would not support a permanent benthic invertebrate community. Therefore, risks associated with the American dipper are likely overestimated. The small-range receptor evaluation indicated that all samples were below LOAEL-based benchmarks.

Because of the low HQs observed under maximum and refined assumptions, barium and selenium risks associated with direct and indirect ingestion pathways in the Northern Surface Water Feature are considered to be of low concern in this exposure area.

6.3 Aquatic Exposure Areas

The following sections present risk estimates and risk characterizations for aquatic exposure areas evaluated at the Site.

6.3.1 Flathead River

Risk estimates and the baseline risk characterization for direct contact and ingestion exposure pathways are presented below for the Flathead River. Risk estimates are presented based on sediment and surface water data for the entire Flathead River dataset including the Backwater Seep Sampling Area that has been regulated under MPDES Permit No. MT0030066 and for Flathead River data excluding samples within the Backwater Seep Sampling Area (**Figure 2-2**).

6.3.1.1 Direct Contact Risk Estimate

Risk estimates and risk characterization for direct contact exposure pathways are presented below for the Flathead River. Risk estimates are presented based on sediment and surface water data for the entire Flathead River dataset including the Backwater Seep Sampling Area and for the Flathead River data excluding samples within the Backwater Seep Sampling Area.

Direct contact risk estimates indicate that the greatest exposure to COPECs in sediment, pore water, and surface water within the Flathead River is associated with the Backwater Seep Sampling Area. Benthic invertebrate risk estimates indicate that maximum COPEC concentrations exceed benthic invertebrate NOECs in sediment for total cyanide and $\sum ESBTU_{34}$ values (**Table 6-40; Figure 6-33**). Maximum COPEC concentrations in sediment are below benthic invertebrate LOECs for all COPECs, except total cyanide and $\sum ESBTU_{34}$ values for PAHs at three stations (**Table 6-40; Figure 6-33**). Based on refined sediment exposure concentrations, only cyanide exceeded the benthic invertebrate LOEC (HQ_{LOEC}=1.7; **Table 6-40**).

Pore water samples indicate exceedances of benthic invertebrate NOECs for free cyanide, fluoride, and barium and LOECs for barium and free cyanide. Maximum concentrations of free cyanide exceed pore water NOECs (HQ_{NOEC}=12.0) and LOECs (HQ_{LOEC}=2.8; **Table 6-41**). Maximum barium concentrations exceed NOECs and LOECs (HQ_{LOEC}=6.7); however, barium concentrations in pore water remain consistent in samples collected upstream of the site on the Flathead River (CFPWP-017) to barium concentrations in samples collected within the Backwater Seep Sampling Area (**Figure 6-33**), and barium concentrations outside of the Backwater Seep Sampling Area are consistent with background (Roux, 2019). This indicates that barium concentrations in pore water may be associated with regional conditions and not related to pathways from the site. The results of AVS-SEM and pore water analyses in sediment indicate divalent metals are not bioavailable at concentrations likely to result in adverse effects to benthic invertebrates (less than 130 µmol/g_{OC}).

The greatest direct contact exposure to surface water in the Flathead River is also associated with samples collected in the Backwater Seep Sampling Area. Based on the entire Flathead River dataset, maximum concentrations of cyanide (total and free), unfiltered aluminum, barium (filtered and unfiltered), and iron exceeded NOECs based on chronic NRWQC and DEQ-7 criteria for the protection of aquatic life (**Table 6-42**). Maximum concentrations of cyanide (total and free), unfiltered aluminum, and barium (filtered and unfiltered) exceeded LOECs based on acute criteria for the protection of aquatic life (**Table 6-42**). Maximum total and free cyanide concentrations exceeded NOECs (total cyanide HQ_{NOEC}= 63.1 to 72.7; free cyanide HQ_{NOEC}=8.1 to 26.7) and LOECs (total cyanide HQ_{NOEC}=14.9 to 17.2; free cyanide HQ_{LOEC}=1.9 to 6.3; **Table 6-42**). Unfiltered aluminum concentrations exceeded sample-specific NOECs in 21 of 76 samples, with HQ_{NOEC} values ranging from 1.0 to 28.5 (**Table 6-43**). Unfiltered aluminum concentrations exceeded sample-specific LOECs in 8 of 76 samples (HQ_{LOEC}=1.6 to 17.7; **Table 6-43**). Filtered aluminum concentrations were below NOECs. Maximum barium concentrations exceeded NOECs (filtered HQ_{NOEC}=49.0; unfiltered HQ_{NOEC} 55.4) and LOECs (filtered HQ_{LOEC}=4.9; unfiltered HQ_{LOEC} 5.5; **Table 6-42**).

Refined exposure estimates for cyanide (total and free) and barium (filtered and unfiltered) based on the entire Flathead River dataset also exceeded chronic NOECs and acute LOECs. Refined total and free cyanide concentrations exceed NOECs (total cyanide HQ_{NOEC}=11.9 to 35.2; free cyanide HQ_{NOEC}=4.5 to 5.2) and LOECs (total cyanide HQ_{LOEC}=2.8 to 8.3; free cyanide HQ_{LOEC}=1.1 to 1.2; **Table 6-42**). Refined barium concentrations exceeded NOECs (filtered HQ_{NOEC}=26.6; unfiltered HQ_{NOEC}=30.0) and LOECs (filtered HQ_{LOEC}=2.7; unfiltered HQ_{LOEC}=3.0).

Excluding samples from the Backwater Seep Sampling Area, maximum sediment concentrations only exceeded NOECs and LOECs for PAHs; all other COPECs were less than NOECs (**Table 6-44**). For PAHs, ∑ESBTU values exceeded 1.0 for station CFSDP-036 ($\sum ESBTU_{13}$ = 9.8; $\sum ESBTU_{34}$ = 27). Elevated ∑ESBTU values at this station were attributed to low organic carbon concentrations (0.01 percent) and relatively low total PAH concentrations (1.35 mg tPAH/kg). Pore water samples indicate exceedances of benthic invertebrate LOECs for barium (**Table 6-45)**; however, as previously stated, barium concentrations in pore water remain consistent in samples collected upstream of the site to downstream of the site (**Figure 6-33**), indicating that barium concentrations in pore water may be associated with regional conditions and not related to pathways from the site.

Excluding surface water data from the Backwater Seep Sampling Area, maximum concentrations of barium and unfiltered aluminum exceeded NOECs and LOECs for aquatic organisms (**Table 6-46**). Outside of stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-26 through CFSWP-28), free and total cyanide concentrations were below NOEC benchmarks based on NRWQC CCC and MDEQ chronic criteria, respectively. Unfiltered aluminum concentrations exceeded sample-specific NOECs in 3 of 40 samples, with HQ_{NOEC} values ranging from 1.0 to 28.5. Unfiltered aluminum concentrations exceeded sample-specific LOECs in 3 of 40 samples (HQ_{LOEC}=3.5 to 17.7; **Table 6-47**). Filtered aluminum concentrations were below NOECs. Maximum and refined concentrations of barium (unfiltered and filtered) exceeded NOECs and LOECs, with HQ_{LOEC} values for maximum and refined concentrations in filtered samples ranging from 3.6 to 2.1, respectively (**Table 6-46**). However, similar to pore water, barium concentrations in surface water remain consistent in samples collected the main river channel upstream of the site (CFSWP-017) to downstream of the site (CFSWP-001; **Figure 6-34**). Further, barium concentrations in the Flathead River outside of the Backwater Seep Sampling Area are generally lower than the BTVs calculated for upgradient filtered (122 µg/L) and unfiltered (130 µg/L) datasets. These findings indicate that barium concentrations in surface water is likely associated with regional conditions and not related to pathways from the site.

6.3.1.2 Ingestion Risk Estimate

The screening-level food ingestion model that assumed 100 percent exposure to surface water and sediment in the Flathead River and used maximum concentrations as the EPCs resulted in HQs exceeding 1 for aluminum, vanadium, cyanide, and HMW PAHs for one or more of the aquatic receptors (**Table 6-57**). However, all HQ values were below 10 and no HQ_{LOAEL} values exceeded 1 based on maximum EPCs (**Appendix H**).

The screening-level exposure scenario for wildlife in the Flathead River modeled the maximum exposure scenario for the potential ingestion of total cyanide through dietary, drinking water, and incidental ingestion pathways based on maximum EPCs for surface water (378 µg/L) and sediment (8.3 mg/kg) measured in samples collected from the Backwater Seep Sampling Area (CFSWP-004 and CFSWP-003 for surface water and sediment, respectively). In addition to maximum EPCs, the screening-level wildlife ingestion model assumes an AUF of 1 and therefore, represents the maximum exposure scenario for wildlife that may be associated with a single-dose exposure to total cyanide via ingestion pathways while foraging within the Backwater Seep Sampling Area. As presented in **Appendix H1**, estimated maximum daily doses of total cyanide were calculated for American dipper (Table H12-2), belted kingfisher (Table H12-3), and mink (Table H12-4) and compared to chronic TRVs for cyanide. This maximum exposure scenario for cyanide resulted in a chronic HQ_{NOAEL} values greater than 1 for American dipper ($HQ_{NOAEL} = 2.3$) and belted kingfisher ($HQ_{NOAEL} = 1.5$); maximum estimated doses for these avian receptors were less than the chronic LOAEL TRV. The drinking water ingestion pathway accounted for 69 percent of the total dose modeled for American dipper and the entire total cyanide dose modeled for belted kingfisher. The maximum modeled mink exposure for total cyanide resulted in a chronic HQ_{NOAEL} value less than 1.

The screening-level risk estimates based on maximum exposure and chronic TRVs for total cyanide are protective of acute exposure scenarios for wildlife that may occur during single-dose exposure while foraging within the Backwater Seep Sampling Area. The chronic mammalian TRVs for cyanide were based on chronic endpoints (LANL, 2017); therefore, acute mammalian TRVs would be greater than the chronic TRVs evaluated in the model. Chronic avian TRVs for total cyanide were based on a lethal dose to 50 percent of test organisms (LD_{50}) endpoint derived from a single-dose acute study (Wiemeyer et al., 1986, as cited in LANL, 2017). The chronic avian NOAEL was derived by dividing the LD_{50} by an uncertainty factor of 100 (LANL, 2017); the chronic LOAEL was estimated by multiplying the chronic NOAEL by an uncertainty factor of 10 (LANL, 2017). Comparing the doses estimated in **Appendix H1** based on the maximum detected total cyanide EPCs in the Backwater Seep Sampling Area directly to the acute LD_{50} results in a maximum HQ_{LD50} of 0.02 for modeled avian receptors. Thus, acute wildlife risks associated with a single-dose exposure scenario of ingesting the maximum detected concentration of cyanide in surface water within the Backwater Seep Sampling Area 100 percent of the time indicates minimal acute risk for modeled wildlife receptors.

The refined food chain model using more realistic assumptions resulted in only vanadium (American dipper and belted kingfisher) and HMW PAHs (American dipper, belted kingfisher, and mink) having an HQ_{NOAEL} greater than 1 (**Table 6-48**). No HQ_{LOAEL} values exceeded 1. Risk associated to vanadium and HMW PAHs originated from sediment (rather than surface water) (**Appendix H2**). Vanadium and several PAHs were found to be higher than upgradient reference area sediment data in the hypothesis testing (Roux, 2019). However, because of the very low HQs in the refined evaluation (all HQ_{NOAEL} values were below 5, no HQ_{LOAEL} values above 1) (**Table 6-59**), ecological risk to wildlife associated with direct and indirect ingestion of media in the Flathead River is considered minimal.

6.3.1.3 Risk Characterization

The evaluation of Flathead River sediment, pore water, and surface water data indicate that the greatest potential for ecological exposure to site-related constituents is associated with aqueous exposure pathways within the Backwater Seep Sampling Area, and areas where groundwater containing cyanide and fluoride discharges to surface water. Elevated sodium concentrations in surface water samples from the Backwater Seep Sampling Area are consistent with elevated sodium concentrations observed in groundwater wells adjacent to the Backwater Seep Sampling Area that are screened within the upper hydrogeologic unit. Elevated sodium concentrations in these wells are indicative of the potential groundwater discharge pathway (Roux, 2019). The discharge of cyanide and fluoride in groundwater to the Flathead River adjacent to the Site was previously authorized by MPDES permit number MT-0030066 since first issued in May 1994, and subsequently renewed in 1999 and July 2014. On January 24, 2019, MDEQ provided a Notice of Intent to terminate the permit.

Surface water exposure was greatest to cyanide (total and free), barium, and aluminum, with greater concentrations observed in the Backwater Seep Sampling Area and adjacent stations immediately downstream of the Backwater Seep Sampling Area (CFSWP-26 through CFSWP-28). Attenuation of surface water concentrations occurs rapidly with increasing distance from the Backwater Seep Sampling Area, particularly during periods of elevated discharge within the Flathead River (**Figure 6-34; Figure 6-35**). Outside of the stations within the Backwater Seep Sampling Area and stations along the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-26 through CFSWP-28), free and total cyanide concentrations did not exceed chronic NRWQC- and DEQ-7-based benchmarks, respectively, in multiple rounds of surface water sampling events. At surface water sampling stations on the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-26 through CFSWP-28), total cyanide exceeded the chronic DEQ-7-based NOEC and acute DEQ-7-based LOEC in at least one sample at each station. Free cyanide concentrations were below the NRWQC-based NOEC at stations CFSWP-26 and CFSWP-27, but exceeded the free cyanide NOEC at CFSWP-28. None of the stations on the shoreline immediately downstream of the Backwater Seep Sampling Area (CFSWP-26 through CFSWP-28) exceeded the acute NRWQC-based LOEC for free cyanide. This finding indicates that the potential area of exposure to aquatic receptors at concentrations exceeding NOECs and LOECs based on NRWQC (free cyanide) and MDEQ (total cyanide) benchmarks is spatially-limited to a groundwater-surface water mixing zone along the shoreline within and immediately adjacent to the Backwater Seep Sampling Area.

A statistical evaluation of spatial and temporal trends was conducted to assess the effect of discharge percentile on COPEC concentrations in the Backwater Seep Sampling Area and adjacent stations in the Flathead River. Variability in surface water concentrations of fluoride, total cyanide, aluminum, and barium across sampling phases were grouped by three areas: 1) the Downstream Portion of the Flathead River – stations CFSWP-001, -034, -002, -035, -026, -027, and -028; 2) the Backwater Seep

Sampling Area of the Flathead River – stations CFSWP-003, -004, and -005); and, 3) the Flathead Riparian Area Channel (CFSWP-029 to -033) (**Figure 4-13**). The effect of discharge percentiles discussed in **Section 4.1.2** on surface water concentrations of fluoride and total cyanide as well as unfiltered and filtered aluminum and barium were evaluated for each area using a one-way analysis of variance (ANOVA). Constituent concentrations are illustrated in **Figure 6-35** by discharge percentile. In addition, the suspected interaction effects of discharge percentiles and area on concentration were evaluated to assess whether the temporal response in concentration was consistent for each area (**Figure 6-36**). The results of one- and two-way ANOVAs are summarized in **Table 6-60**.

Findings from the evaluation of the effect of discharge percentile on concentration for each area supports the observations discussed in the ECSM (**Section 3.3.5**). Significantly less fluoride was observed in the Downstream Portion of the Flathead River and the Backwater Seep Sampling Area at greater discharge percentiles (**Table 6-60**). Discharge percentile did not have a significant effect on fluoride concentration in the Flathead Riparian Area Channel. Cyanide exhibited similar patterns as fluoride in the Downstream Portion of the Flathead River and Backwater Seep Sampling Area. However, significantly greater cyanide was observed in the Flathead Riparian Area Channel at periods of elevated discharge (**Table 6-60**). Significant two-way interactions of area and discharge (Q) percentile indicate that the riparian channel does not respond in a consistent manner to the Backwater Seep Sampling Area and downstream portion of the Flathead River (**Table 6-60; Figure 6-36**). Discharge percentiles did not have a significant effect on filtered or unfiltered aluminum concentrations across all three areas. Patterns of unfiltered and filtered barium were consistent across the Downstream Portion and Backwater Seep Sampling Area, with significantly lower concentrations during elevated flow conditions (**Table 6-60**). Concentrations of barium outside of the Backwater Seep Sampling Area were also consistent with concentrations detected in the main channel of the Flathead River, as well as the background area in the Flathead River upstream of the Site.

The potential for adverse ecological effects associated with COPEC concentrations in the Backwater Seep Sampling Area was further evaluated based on biological data collected by CFAC in support of the MPDES permit for Outfall 006. CFAC has conducted 18 quarterly Whole Effluent Toxicity (WET) testing studies (Fourth Quarter 2014 to First Quarter 2019) to evaluate the potential for acute toxic effects in the Backwater Seep Sampling Area. Toxicity tests were conducted using Fathead Minnow (*Pimephales promelas*) and the daphnid (*Ceriodaphnia dubia*) and a dilution series of groundwater seep water from Outfall 006 (USEPA, 2002). Fathead minnow is a relatively sensitive fish species to cyanide exposure (Broderius et al., 1977; Doudoroff, 1956; Smith et al., 1978) and daphnids are more sensitive to cyanide exposure than aquatic insects and other macroinvertebrate test organisms (Gensemer et al., 2007; Gensemer et al., 2006).

Exposure to 100 percent effluent from the groundwater seep did not result in an LC_{50} for Flathead Minnow or daphnid test organisms in any sample (**Table 6-61**). These results indicate that cyanide or other COPECs are not likely present in a toxic form or at concentrations in surface water in the Backwater Seep Sampling Area that are sufficiently elevated to elicit acute toxicity in invertebrate or fish test organisms that are relatively sensitive to cyanide exposure.

Further analysis of the results of 18 quarterly WET testing samples indicates that aqueous exposure to the groundwater seep dilution series did not materially affect the survival of Fathead Minnow and had a relatively minor effect on the survival of daphnid test organisms in short-term exposures (48- to 96-hours; **Figure 6-37**). A one-way ANOVA was conducted to test for statistically significant differences ($p < 0.05$) in mean percent survival across the dilutions series for Fathead Minnow and daphnid test organisms assessed in 18 quarterly sampling events. There was no significant effect of the percent effluent on the percent survival of Fathead Minnow in undiluted effluent (100 percent effluent) or the dilution series exposures ($p > 0.05$; **Figure 6-37; Table 6-62**). However, a statistically significant ($p < 0.001$) main effect of percent effluent was identified for the percent survival of daphnid test organisms. Further pairwise testing of the effect of percent effluent using Tukey's Honest Significant Difference (HSD) test indicated significant differences ($p < 0.05$) in mean percent survival in undiluted effluent (100 percent effluent) compared to the dilution series (50 - 6.25 percent effluent) and the 0 percent effluent control treatment (**Figure 6-37; Table 6-62**). However, the difference in mean survival was relatively minor, as mean survival (± standard error) of daphnid test organisms in the undiluted treatment (100 percent effluent) was 91.4 ± 1.9 percent. Mean daphnid survival in the diluted treatments (50 - 6.25 percent effluent) was not significantly different from mean survival in the control sample (0 percent effluent) or any diluted exposures (**Figure 6-37; Table 6-62**). These findings indicate that 50 percent or greater dilution of discharging groundwater by surface water from the Flathead River in the Backwater Seep Sampling Area is likely sufficient to mitigate any short-term effects on the survival of representative fish and invertebrates.

The lack of substantial mortality relative to control across the WET testing dilution series also indicates that no other COPECs were present in test samples in a form or concentrations that are acutely toxic to aquatic life during short-term exposures. Further, the lack of substantial mortality in the dilution series relative to control over 18 quarters of testing indicates that acute effects are not likely in groundwater discharge that is diluted by 50 percent or greater by surface water in the Flathead River. These findings are consistent with the MDEQ Statement of Basis that accompanied the 1999 MPDES Permit No. MT-00330066 (MDEQ, 1999), which previously authorized the discharge of groundwater to the Flathead River, including the Backwater Seep Sampling Area, from 1994 through April 17, 2019. The MDEQ Statement of Basis indicated no anticipated impacts on aquatic species or other species (**Section 3.3.3)**.

As previously stated in **Section 3.3.3**, the section of the Flathead River that includes the Backwater Seep Sampling Area has limited fish habitat for common species and is primarily used as a migration corridor to access areas of more suitable habitat (Stagliano, 2015). As a result, fish exposure to cyanide in surface water in the Backwater Seep Sampling Area is likely spatially-limited near points of groundwater discharge and temporally-limited to exposure during migration. Further, the lack of spawning or nursery habitat in the reach of the Flathead River near the Site limits exposure to early life stages that may have greater sensitivity to exposure. These findings are consistent with the MDEQ Statement of Basis that accompanied the 1999 MPDES Permit No. MT-00330066 (MDEQ, 1999), which indicated that area of exceeding acute cyanide standards would not inhibit fish migration and that there were no impacts to spawning or nursery areas or attraction to cyanide within the mixing zone (**Section 3.3.3)**. Subadult bull trout and other native fish may increasingly use channel margin habitat like that of the Backwater Seep Sampling Area during periods of increased flows (David Rouse, U.S. Fish and Wildlife Service, information received in agency comments on the Draft BERA). However, this period of increased flows is limited in duration (typically greater than the 90th percentile discharge rate from April to June; see **Figure 3-5**) and coincides with lower cyanide exposure concentrations in surface water resulting from dilution by increased surface water discharge in the Flathead River (**Figure 6-35**).

The results of toxicity testing indicate low potential for acute effects to fish and aquatic invertebrate test organisms resulting from exposure to cyanide and COPECs in surface water in the Backwater Seep Sampling Area. However, it should be noted that WET testing results represent a snapshot of exposure that may not capture the temporal variability in the toxicity of groundwater discharge in the Backwater Seep Sampling Area. Further, the dynamic environmental conditions that control the fate of toxic forms of cyanide (see **Section 3.3.7.1**) present *in situ* within the Backwater Seep Sampling Area may not be adequately represented in *ex situ* toxicity tests conducted in a laboratory. In addition to these uncertainties regarding acute effects, there is uncertainty in potential chronic, direct contact effects to aquatic and benthic receptors exposed to cyanide in the spatially-limited area of the Backwater Seep Sampling Area that receives ongoing inputs from groundwater discharge. Free cyanide is not expected to persist in surface water due to photodegradation and volatilization (MDEQ, 1999) or in sediment based on limited partitioning (Higgins and Dzombak, 2006); however, potential input from shallow groundwater may be an ongoing pathway to pore water and *in situ* dissociation of metal-cyanide complexes may be an ongoing source of free cyanide in surface water within the Backwater Seep Sampling Area. These conditions result in exceedances of acute and chronic NRWQC for free cyanide and acute and chronic DEQ-7 criteria for total cyanide in samples collected from stations within the Backwater Seep Sampling Area (CFSWP-003 through CFSWP-005). As demonstrated by the temporal analysis presented above, the greatest exposure to cyanide in this area likely occurs during low discharge periods within the Flathead River.

As discussed in **Section 6.3.1.2**, the wildlife ingestion model indicated that HQ_{NOAEL} values for vanadium and PAHs exceeded 1, but no HQ_{LOAEL} values exceeded 1. Elevated cyanide concentrations detected in surface water within the Backwater Seep Sampling Area were evaluated in the screening-level wildlife ingestion model using a worst-case scenario in which modeled receptors were assumed to ingest drinking water with the greatest detected cyanide concentration (378 µg/L) 100 percent of the time. The results of this model indicated that the maximum HQ_{NOAEL} based on ingestion of cyanide in drinking water was 1.57 for the American Dipper based on chronic TRVs (see **Appendix H1; Table H12-2**). The maximum HQ_{NOAEL} for cyanide based on dietary, incidental sediment ingestion, and drinking water exposure pathways was slightly higher (HQ = 2.26) for the American Dipper. HQ_{LOAEL} values were well below 1 for summed pathways for each receptor based on chronic TRVs. The risk modeled using the chronic cyanide TRVs is protective of acute risk, as evidenced by the fact that the avian TRV was developed by dividing an acute LD_{50} TRV endpoint by 100 to derive the chronic TRV (LANL, 2017). Because cyanide is rapidly metabolized and does not bioaccumulate (USEPA, 1985), adverse effects to semi-aquatic wildlife potentially foraging in or ingesting surface water exclusively in the Backwater Seep Sampling Area are also not likely. Therefore, potential risks associated with direct and incidental wildlife ingestion pathways are considered to be minimal.

6.3.2 Flathead River Riparian Area Channel

Risk estimates and the baseline risk characterization for direct contact and ingestion exposure pathways are presented below for the Flathead River Riparian Channel.

6.3.2.1 Direct Contact Risk Estimate

Direct contact risk estimates for sediment indicate that the greatest exposure in the Riparian Channel is associated with sampling stations near the Backwater Seep Sampling Area. Risk estimates for benthic invertebrates indicate that maximum concentrations are below NOECs for all COPECs, except total cyanide, barium, and ∑ESBTU values (**Table 6-49**); the maximum concentration of total cyanide was the only concentration exceeding its benthic invertebrate LOEC (HQ_{LOEC}=1.7). The maximum cyanide concentration and maximum ∑ESBTU value were observed at stations CFSDP-29 and CFSDP-30, respectively (**Figure 6-38**). Refined concentrations did not exceed LOECs, except for a slight exceedance of total cyanide (HQ_{LOEC}=1.1). Pore water concentrations of free cyanide exceeded the chronic NRWQC-based NOEC at 3 of 5 stations (maximum HQ_{NOEC}=7.4) and acute NRWQC-based LOEC at 2 of 5 stations (maximum HQ_{LOEC}= 1.8 at station CFPWP-029) (**Figure 6-38; Table 6-50**). Total cyanide concentrations exceeded the DEQ-7 chronic NOEC and acute LOEC at all five stations (maximum HQ_{NOEC} = 82.5 and maximum HQ_{LOEC}= 19.5 at station CFPWP-029). Maximum barium concentrations exceed NOECs and LOECs (HQ_{LOEC}=10.1). Maximum concentrations of PAHs in pore water were lower than NOECs, indicating limited bioavailability and exposure to PAHs in the Flathead Riparian Area Channel.

The greatest direct contact exposure to COPECs in surface water within the Flathead Riparian Area Channel was associated with stations adjacent to the Backwater Seep Sampling Area and the South Percolation Ponds. Maximum concentrations of total cyanide, free cyanide, fluoride, aluminum (unfiltered), and copper (unfiltered) exceeded NOECs and LOECs (**Table 6-51; Table 6-52**). Maximum concentrations of cyanide (total and free) were observed at Station CFSWP-029, located at the eastern edge of the Backwater Seep Sampling Area (**Figure 6-39**), resulting in HQ_{LOEC} values in unfiltered samples ranging from 28.6 (total cyanide) to 6.4 (free cyanide); refined concentrations resulted in HQ_{LOEC} values in unfiltered samples ranging from 15.6 (total cyanide) to 2.8 (free cyanide; **Table 6-51**). Unfiltered aluminum concentrations exceeded sample-specific NOECs in 6 of 15 samples, with HQ_{NOEC} values ranging from 1.2 to 41.6 (**Table 6-52**); unfiltered aluminum concentrations exceeded sample-specific LOECs in 3 of 15 samples (HQ_{LOEC}=1.8 to 10.7; **Table 6-52**). Filtered aluminum concentrations were below NOECs. Unfiltered copper samples exceeded NOEC and LOEC values in 2 of 15 samples (HQ_{LOEC} =1.0 to 2.0; **Table 6-52**). Maximum and refined concentrations of barium (unfiltered and filtered) exceeded LOECs, with HQ_{LOEC} values for maximum and refined concentrations in filtered samples of 10.3 and 6.9, respectively (**Table 6-51**).

6.3.2.2 Ingestion Risk Estimate

The samples in the Flathead River Riparian Area Channel were collected specifically to more fully characterize the impacts of seep and groundwater influence on the Flathead River. Data from these samples were not included in the food chain model used to estimate potential risk associated with direct and indirect ingestion of constituents in various media. Thus, ingestion risk estimates were not developed for the Flathead River Riparian Area Channel.

6.3.2.3 Risk Characterization

The evaluation of sediment and surface water data in the Flathead River Riparian Channel indicate the potential for adverse effects associated with exposure to cyanide (total and free), fluoride, and metals in surface water. Benthic invertebrate exposure to COPECs in sediment was limited to exposure to total and free cyanide, barium, and a $\sum ESBTU_{FCV,Total}$ value exceeding 1.0 at one of five stations. Exposure to cyanide (total and free) and barium in sediment is associated with aqueous exposure in pore water. Free cyanide is not expected to persist in sediment based on limited partitioning (Higgins and Dzombak, 2006); however, potential input from shallow groundwater appears to be an ongoing pathway to pore water in the Flathead River Riparian Channel. Free and total cyanide concentrations in pore water samples exceeded NRWQC and DEQ-7 chronic (NOECs) and acute (LOECs) criteria. Low PAH concentrations measured in pore water indicate low PAH bioavailability and minimal potential for adverse effects.

Surface water data indicate potential exposure to COPECs may be influenced by groundwater discharge associated with the Backwater Seep Sampling Area and surface discharge from the South Percolation Pond Area. As stated in **Section 6.3.1.3**, the results of surface water toxicity testing in the Backwater

Seep Sampling Area did not indicate a significant acute effect on the survival of Ceriodaphnid and Fathead Minnow test organisms exposed to cyanide and other COPECs associated with groundwater discharge that was diluted by 50 percent or greater in test chambers (**Section 6.3.1.3)**. However, there is uncertainty in potential chronic direct contact effects to aquatic and benthic receptors in the Flathead Riparian Area Channel that may be exposed to cyanide and other COPECs through ongoing inputs from groundwater discharge. As demonstrated by the temporal analysis presented in **Section 6.3.1.3**, the greatest chronic exposure to cyanide in Flathead Riparian Area Channel likely occurs during periods of elevated discharge within the Flathead River (**Figure 6-35**).

6.3.3 Cedar Creek

Risk estimates and the baseline risk characterization for direct contact and ingestion exposure pathways are presented below for the Cedar Creek.

6.3.3.1 Direct Contact Risk Estimate

Direct contact risk estimates for aquatic receptors inhabiting Cedar Creek indicate minimal potential for adverse effects for benthic invertebrates exposed to cyanide, metals, and PAHs (**Table 6-53**). Maximum concentrations of COPECs in sediment resulted in minor exceedances of NOECs for cyanide (HQ_{NOEC}=2.4), barium (HQ_{NOEC}=1.7), manganese (HQ_{NOEC}=1.2; **Table 6-53**). $\sum ESBTU_{34}$ values slightly exceeded 1.0 at one station ($\sum ESBTU_{34}$ = 1.3). Refined concentrations exceeded NOECs only for total cyanide (HQ_{NOEC}=1.6) and barium (HQ_{NOEC}=1.1). PAHs were not detected in pore water; barium and manganese were the only COPECs detected in pore water at concentrations exceeding LOECs (**Table 6-54**). Barium concentrations in pore water remain consistent in samples collected from the upstream station in Cedar Creek (CFPWP-014) to the most downstream Cedar Creek station (CFPWP-016; **Figure 6-40**). This indicates that barium concentrations in pore water may be associated with regional conditions and not related to pathways from the Site.

Direct contact aqueous risk estimates indicate negligible potential for adverse effects associated with surface water exposure to cyanide and barium (**Table 6-55**). Maximum total and free cyanide concentrations exceeded the DEQ-7 based NOEC for total cyanide and NRWQC based NOEC for free cyanide resulting in HQ_{NOEC} values of 2.9 and 1.5, respectively. However, cyanide (free and total) did not frequently exceeded chronic NOECs in surface water samples collected from Cedar Creek. Free cyanide was detected in 2 of 20 samples and exceeded the NRWQC based NOEC in 1 of 20 samples. Total cyanide was detected in 7 of 22 samples and exceeded the DEQ-7 based NOEC in 2 of 22 samples. Maximum concentrations of barium in surface water samples exceeded the NOEC and LOEC (HQ_{LOEC} 3.0 to 3.3). Barium concentrations in surface water samples were consistent upgradient to downgradient and during the multiple sampling events (**Figure 6-41**). Further, barium concentrations in surface water are comparable to the BTV calculated from upgradient filtered samples off-site in Cedar Creek (99.8 µg/L; Roux, 2019). These findings indicate that direct contact exposure within the Cedar Creek is consistent with regional conditions and not associated with site-related pathways.

6.3.3.2 Ingestion Exposure Estimate

The screening-level food ingestion model that assumed 100 percent exposure to surface water and sediment in Cedar Creek and used maximum concentrations as the EPCs resulted in HQ_{NOAEL} that slightly exceeded 1 (1.1) for the American Dipper exposed to barium (**Table 6-57**) (**Appendix H**).

The results of the refined food chain model using more realistic assumptions were similar, with the American dipper having an HQ_{NOAEL} that slightly exceeded 1 (1.06) for barium. No HQ_{LOAEL} values exceeded 1 (**Table 6-56**). Barium in Cedar Creek sediment was found to be comparable to background in the comparison of populations to upgradient reference area sediment data (Roux, 2019). Thus, ecological risk to wildlife associated with direct and indirect ingestion of media in Cedar Creek is considered minimal.

6.3.3.3 Risk Characterization

Potential risks associated with direct contact with surface water and sediment in Cedar Creek are considered to be negligible. Cyanide (free and total) did not frequently exceeded chronic NOECs in surface water samples collected from Cedar Creek over multiple sampling events. Maximum concentrations of barium in surface water exceeded NOECs and LOECs in some samples, but the magnitude of exceedance was low, and no other constituents had EPCs that exceeded LOECs. No constituents in sediment were detected at concentrations that exceeded their LOECs. Pore water concentrations exceeded their LOECs for barium and manganese, but the HQ for manganese did not exceed 1 when rounded. Barium concentrations in surface water and pore water are consistent upgradient to downgradient, suggesting that concentrations are representative of upgradient/background conditions. Also, the concentrations in surface water (mean = 99.7 µg/L, refined EPC = 105 µg/L for filtered barium) and pore water (mean = 146 µg/L, maximum = 269 µg/L for filtered barium) were comparable to the upgradient reference area concentrations in Cedar Creek (mean = 91 µg/L, BTV = 99.8 µg/L for filtered barium), which indicates that concentrations of barium within Cedar Creek is consistent with regional conditions and not associated with site-related pathways.

Barium concentrations resulted in an HQ_{NOAEL} for the American Dipper that slightly exceeded 1 (1.1) for barium, but no HQ_{LOAEL} values exceeded 1. As discussed in the previous paragraph, barium in Cedar Creek surface water was comparable to background levels. Therefore, ecological risk to wildlife associated with direct and indirect ingestion of media in Cedar Creek is considered minimal.

7 Uncertainty Analysis

A critical component of the BERA is the analysis of uncertainty that is inherent in the ERA process. A thorough uncertainty analysis is necessary to understand how potential uncertainty may affect the risk estimates and associated risk characterization that may be used to support risk management decision-making.

7.1 Adequacy, Representativeness, and Quality of Sampling Data

The BERA was performed using a dataset that was compiled during multiple investigation phases. Phase I data were collected in 2016 and 2017. Additional data was collected during the Supplemental South Pond Assessment in late 2017, and the Phase II data were collected in 2018. The use of data from samples collected during three separate field mobilizations allowed for an evaluation of the Phase I data and the development of a follow-on sampling strategy designed to address any data gaps or uncertainties revealed by earlier sampling events. The Phase II sampling effort was designed to provide (along with Phase I data) a comprehensive data base that would provide confidence in any decisions and recommendations generated by evaluations based upon it. To accomplish this goal, the objectives of the Phase II effort were to address data gaps in the Phase I data and provide additional critical information regarding the characterization, nature and extent, bioavailability, fate and transport, and toxicity of possible COPECs associated with historical source areas. The strategy for accomplishing this was provided in the Phase II SAP (Roux, 2018a), which was reviewed and approved by project stakeholders. Data quality was reviewed and determined to be acceptable in the Phase I and Phase II Data Summary Reports (Roux 2017a, 2019). Therefore, the adequacy, representativeness, and quality of the sampling data is judged to be adequate for Site decisions regarding ecological exposure at the facility.

USEPA and MDEQ review of the Phase II DSR indicated that the report was clear, detailed, and complete, and generally contains the data needed to complete the risk assessments and feasibility study. Should additional investigations or actions be necessary in areas where unacceptable ecological risk is identified, the need for additional sample collection for the purposes of further delineation characterization, or risk management will be evaluated and discussed in the Feasibility Study for specific COPECs and exposure pathways that have been identified for risk management at the Site.

7.2 Temporal (Seasonal) Variability in Exposure

Temporal variability contributes to variability in ecological exposure conditions at the Site, particularly with regards to the exposure pathway between groundwater and seep/surface water entering the Flathead River. Phase I data provided some information regarding river stage and seasonality on the variability of key COPECs such as cyanide and fluoride and their discharge rates into surface water bodies. The Phase II sampling effort provided additional data to further refine the relationships between surface water COPEC concentrations and hydrology during various times of the year. Sediment samples from the Flathead River exposure area (including the Backwater Seep Sampling Area) were collected during low flow periods exclusively, when the Flathead River would most likely be acting as a gaining stream. An approximately equal number of surface water samples were collected during low (41 samples) and high flow (36 samples) hydraulic conditions (see **Table 4-12**). Thus, sediment results for this exposure area are expected to be conservative, and surface water results are expected to reflect year-round exposure. However, it is noted that the maximum EPCs used in the screening-level wildlife exposure models represent the maximum seasonal exposure scenario. The temporal evaluation presented in **Section 4.1.2.2** indicates that surface water sampling conducted during Phase I and Phase II investigations comprise a wide range of hydrologic conditions that effectively capture the temporal variability of exposure conditions that are influenced by surface water discharge (**Figure 3-5**). Therefore, uncertainty associated with temporal/seasonal variability in exposure has largely been addressed in the BERA.

Another seasonal influence on ecological exposure and risk involves the seasonal inundation of some low-lying or seep-influenced portions of the site. These areas were evaluated as transitional exposure areas in the BERA, and complete evaluations were performed assuming that conditions were both dry (during which terrestrial exposure scenarios were evaluated) and wet (during which semi-aquatic exposure scenarios were evaluated). By evaluating both scenarios assuming the site conditions were inundated or dry 100 percent of the time, the BERA provides a conservative evaluation of both terrestrial and semi-aquatic exposure (i.e., no temporal adjustment was used to "dilute" one scenario or the other by assuming that exposure only occurred part of the time).

7.3 Exposure to Pathways Not Included in the BERA

The pathways evaluated in the BERA are intended to capture a majority of the potential exposure to constituents in relevant media. However, constituents can enter organisms from a multitude of pathways, not all of which can be fully quantified in a risk assessment. Studies have shown that ingestion and direct contact are the most significant pathways, but other modes of exposure into a receptor are possible. Not quantifying risk associated with those pathways could result in an underestimation of total risk. Perhaps the most potentially significant pathways not evaluated in the risk assessment are dermal exposure and inhalation of COPECs. Dermal and inhalation exposure routes for wildlife are typically not addressed because they are considered minor relative to ingestion, and due to the lack of science supporting the evaluations. Dermal exposure is assumed to be negligible for birds and mammals due to the presence of fur and feathers. Dermal contact to amphibians and aquatic organisms is considered through the use of protective water quality and sediment benchmarks that are inclusive of this route of exposure. Some circumstances may exist where dermal and inhalation exposure may be significant, such as for burrowing wildlife and those species that inhabit burrows of others. However, based on COPEC fate and transport considerations, it is unlikely that risk from inhalation exposure is significant at the Site. Constituents that are most likely to volatilize to the air (i.e., VOCs) are not the primary COPECs at the site and were generally detected at trace concentrations in site media, and only six VOCs were identified as COPECs across all exposure areas. Therefore, it is unlikely that ecological risk was significantly underestimated by the absence of quantified risk associated with dermal or inhalation exposure pathways.

7.4 Potential Exposure to Constituents Not Detected in the Datasets

The sampling locations and analytical methods used to collect environmental data at the Site were described in detail in various work plans reviewed and approved by regulatory agencies. The sampling and analysis strategy was designed to target areas where known or suspected waste streams associated with plant operations may have impacted environmental media. A sensitivity analysis was performed prior to the sampling effort to ensure, to the extent possible, that the analytical methods employed were sensitive enough to detect constituent concentrations associated with potential adverse effects to ecological receptors. However, 100 percent attainment of this objective was not achieved, and some constituents that were not detected in any samples had detection limits that exceeded protective benchmarks, resulting in some uncertainty regarding their presence at concentrations that are undetectable, yet potentially toxicologically significant. This source of uncertainty was discussed in the COPEC selection uncertainty analysis (**Section 4.6**), where it was concluded that this was a minor source of uncertainty that was highly unlikely to affect BERA conclusions.

7.5 Potential Exposure to Constituents Lacking Ecotoxicity Data

Toxicity data that allow for a quantitative assessment of risk are not available for some constituents. The COPEC selection uncertainty section (**Section 4.6**) discussed constituents that lacked ESVs and concluded that the lack of ESVs was unlikely to affect BERA conclusions, as the constituents most likely to adversely affect ecological receptors detected in site media did have ESVs that could be used to help determine if the constituent should be carried forward for further evaluation. The risk characterization portion of the BERA utilized TRVs as benchmark values to assess if modeled doses to various receptors exceeded no-observed and lowest-observed effect doses. However, several constituents identified as COPECs with the potential to bioaccumulate lacked TRVs, including antimony (birds), and dibenzofuran (birds and mammals). Antimony was identified as a COPEC in several exposure areas, but dibenzofuran was only a COPEC at the Central Landfills Area and the North Percolation Pond Area. Dibenzofuran was identified as a potentially bioaccumulative constituent because its log K_{ow} slightly exceeds the criterion of 3.5 (3.7). The presence of dibenzofuran at the North Percolation Pond Area is somewhat irrelevant due to the number of constituents identified as likely risk drivers in that exposure area. At the Central Landfills Area where estimated risk due to ingestion pathways was much less definitive, the presence of dibenzofuran represents a minor uncertainty. Dibenzofuran was detected in approximately half (52 of 110) soil samples at concentrations ranging from 0.0016 mg/kg to 15 mg/kg. Because it was detected frequently in site soil at concentrations that do not resemble a gradient consistent with pathways from site source areas, the presence of dibenzofuran in soil at the Central Landfills Area is unlikely related to a release and is a minor uncertainty in the BERA.

For the direct contact evaluation, NOEC/LOEC data were unavailable for some constituents. Perhaps the greatest uncertainty was the lack of soil and surface water LOEC for benchmarks for PAHs, which were a primary COPEC at many exposure areas. LOECs help to bound site risks and can provide a level above which the potential ecological risk becomes more likely. However, bulk concentrations in media and comparison to NOECs (including considering the magnitude of exceedance) provided sufficient information in most cases to determine whether PAHs should be candidates for additional action within a given exposure area. Therefore, the uncertainty associated with the lack of LOECs for PAHs is not substantial.

Two nutrients, calcium and sodium, were detected at elevated concentrations in site media, but additional toxicity data to assess potential impacts to ecological receptors are lacking. Calcium may be related to historical Site processes due to its association with fluorite, which is a component of feedstocks used in smelting. Calcium was detected at elevated concentrations that exceeded the range of BTVs from multiple background reference areas by an order of magnitude. However, the maximum concentration detected at the Site (313,000 mg/kg) was within the concentration range observed in Western U.S. soils (maximum = 320,000 mg/kg). Furthermore, the range of means detected within the multiple exposure areas at the Site (8,152 mg/kg to 125,544 mg/kg) were well within the range of concentrations of Western U.S. soils. Thus, the average concentration experienced at any exposure area is less than half the upper limit of naturally occurring calcium concentrations in western soil. The highest mean and maximum concentrations of calcium in soil/sediment were within the South Percolation Pond

Area (mean = 125,543 mg/kg). The Flathead River Riparian Area, which surrounds the South Percolation Pond, had mean (20,260 mg/kg) and maximum (41,600 mg/kg) concentrations of calcium approximately an order of magnitude lower than the South Percolation Pond. Therefore, although calcium is elevated in the South Percolation Pond, these elevated concentrations are relatively isolated, and are within the upper limits of naturally occurring calcium in the western U.S. Therefore, the inability to quantify risk associated with elevated calcium in soil at the Site represents a relatively minor uncertainty.

Sodium and calcium were detected at elevated concentrations compared with background in unfiltered and filtered surface water samples. The greatest sodium and calcium concentrations in surface water were associated with sampling stations in exposure areas where groundwater discharge is a potential migration pathway: the Flathead River within the Backwater Seep Sampling Area, Flathead Riparian Area Channel, South Percolation Pond Area, and the Northern Surface Water Feature. Elevated sodium and calcium concentrations in surface water samples from these features is consistent with elevated sodium concentrations observed in groundwater wells screened within the upper hydrogeologic unit at the Site, which are indicative of the potential groundwater discharge pathway (Roux, 2019). Sodium is a possible constituent of historical waste streams due to its presence as sodium cyanide (NaCN). This cyanide salt is highly soluble, which is consistent with the presence of much more highly elevated concentrations of sodium in groundwater and surface water than in soil at the Site.

7.6 Selection of Substitution Value for Non-Detected Results

HMW/LMW/Total PAHs and TEC calculations for dioxins were performed using multiple substitution strategies for non-detected results to bracket the range of potential concentrations that might be present in the sample. For both PAHs and dioxins, values of zero, one-half the MDL, and the full MDL were used as surrogate values for non-detects. In no situation did the selection of the substitution method affect whether or not the constituent grouping was selected as a screening or refined COPEC (**Appendix B** and **Appendix E**). Therefore, the selection of the substitution value for non-detect resulted in little to no uncertainty for this BERA.

7.7 Background Evaluation Methods

The approaches used in the BERA to determine what constituents were related to natural or ambient environmental conditions imparted a highly conservative bias to the evaluation. The comparison of the exposure area UCL to the mean concentration in background samples at the COPEC refinement stage (**Section 4.4.2**) resulted in very few constituents being eliminated from further consideration, even in areas that are unlikely to be impacted by previous site activities. For example, in the Eastern Undeveloped Area, North-Central Undeveloped Area, and Western Undeveloped Area, only two metals were eliminated from further consideration due to this comparison to background. The second phase of the background evaluation consisted of a hypothesis test that statistically compared the site and background datasets to determine whether they were from the same or different populations. The Background Test Form 2 was used for this evaluation, which states as its null hypothesis that the mean COPEC concentration in samples from the exposure area is greater than the sum of the mean concentration in the respective background area and the substantial difference (Roux, 2018b). Test Form 2 requires a stricter burden of proof because instead of using a null hypothesis that the mean or median concentration of the potentially impacted site area does not exceed the mean or median of background, the null hypothesis that must be "disproven" is that the mean or median of the site exceeds the mean or median of background by a specified amount. Therefore, the use of the Test Form

2 is more protective of the environment by requiring that the data contain evidence of no substantial contamination (EPA, 2015b). However, the use of this test form also increases the chance of a Type II error, or failing to reject the null hypothesis, which in this case is that site concentrations are present above background concentrations. Thus, the use of the Test Form 2 likely resulted in identifying some constituents at the various exposure areas as being significantly greater than background when no statistically significant difference in populations actually exists.

7.8 Appropriateness of Variables Used in the Dose Rate Models

The variables used in the dose rate models that estimated risks associated with direct and indirect ingestion of COPECs to wildlife, including exposure parameters, TRVs, and AUFs, were documented and submitted for regulatory review in the *Technical Memorandum: Proposed Wildlife Exposure Modeling Approach to Support the Baseline Ecological Risk Assessment at the Columbia Falls Superfund Site* (presented in **Appendix A2**) prior to the initiation of the BERA. Selected variables were obtained from general literature sources and compilations of exposure factors developed to support dietary exposure modeling and were intended to reflect a conservative, but not worst-case estimate of exposure and toxicity. For example, mean body weights were used in the food chain modeling, but maximum and UCL_{mean} concentrations were used as initial and refined EPCs, respectively. AUFs used to adjust exposure based on the portion of the affected area that occurs within the home range of the receptor was not considered during the screening evaluation but was incorporated into the refined version of the model. When AUFs were used, contributions of risk from areas outside of the target exposure area were not assumed to be zero; rather, the spatially weighted contributions of COPECs from adjacent exposure areas within the receptor home range were added to estimate the aggregate risk. Finally, both NOAEL and LOAEL TRVs were used to provide context for the potential toxicity of doses incurred by the various receptors.

The use of conservative assumptions (i.e., the use of the maximum EPC and an AUF of 1) in the screening-level wildlife ingestion model combined with the more representative exposure assumptions utilized in the refined models provides sufficient information for decision making at the Site. Because of overall conservativeness of the assumptions and variables used throughout the BERA process, the likelihood of underestimating risk is low. Rather, risk estimates are likely to be overestimated at this stage of the BERA. If additional studies are performed (e.g., site-specific toxicity or uptake studies), the uncertainty associated with this (likely) overestimation may be reduced.

7.9 Uncertainty Associated with the HQ Method of Estimating Risk

Risk estimation was performed through a series of quantitative HQ calculations that compare receptor-specific exposure values with TRVs. HQs are compared to HQ guidelines for assessing the risk posed from COPECs. It should be noted that HQs are not measures of risk, are not population-based statistics, and are not linearly scaled statistics. Therefore, an HQ above 1, even exceedingly so, does not definitively indicate that there is a single organism adversely impacted by the toxicological effect associated with a given constituent to which it was exposed currently or in the future (Tannenbaum, 2005; Bartell, 1996). HQs exceeding 1 only suggest that the potential for adverse hazard may exist, and the probability of adverse effects occurring may increase with increasing HQ magnitude.

7.10 Uncertainty Associated with AVS-SEM Results

As described throughout the BERA (e.g., Sections 3.6 and 4.1.3, etc.) and in the Phase II Sampling and Analysis Plan (Roux, 2018a), AVS-SEM data were collected as part of the Phase II site characterization effort in sediments where divalent metals were suspected or known to be present at concentrations above ESVs based on total recoverable metal analyses. As stated in **Section 3.3.7.4**, the soluble phase of metal ions in sediment pore water is generally the most bioavailable and potentially toxic form to ecological receptors. Equilibrium partitioning theory may be used to predict the bioavailability toxicity of metals in sediment based on the partitioning of SEM between AVS, TOC, and pore water (USEPA, 2005a). In reduced sediments, free metal ions partition to AVS and TOC to form insoluble metal sulfide complexes that have low bioavailability and are associated with low toxicity to benthic organisms in toxicity tests (USEPA, 2005a). Based on this principle, AVS-SEM and TOC data were used in the BERA in conjunction with pore water data to provide multiple lines of evidence to evaluate the bioavailability of divalent metals in sediments in select exposure areas at the Site.

A study performed by Hammerschmidt and Burton (2010) identified potential issues with the reproducibility of AVS-SEM results between laboratories, indicating some uncertainty with AVS-SEM results as the basis for decision-making. The study examined AVS-SEM results for sediment subsamples that were distributed to seven independent laboratories and found varied results (ranging from 70 to 3,500-times for AVS and 17 to 60-times for SEM) owing to varying laboratory preparations, detection limits, and other factors. The information presented in Hammerschmidt and Burton (2010) indicates some uncertainty regarding the accuracy and replicability of AVS-SEM data between laboratories. However, the additional pore water line of evidence collected as part of the Phase II site characterization limits the uncertainty associated with AVS-SEM results. Given that multiple lines of evidence were evaluated in the assessment of metal bioavailability in sediment, the uncertainty associated with AVS-SEM analyses is not likely to affect overall conclusions regarding potential metal toxicity to benthic organisms at the Site

7.11 Calculation of HQs for Large Home Range Receptors

As discussed in **Section 5.3.3.2.1**, low-level contributions from adjacent exposure areas that resulted in an HQ_{NOAEL} of less than 1 for that exposure area were not included in the spatially weighted HQ calculations for large range receptors. This results in a slight underestimation of the aggregate dose for receptors foraging in multiple exposure areas. However, because contributions from adjacent exposure areas are spatially weighted, their impacts on the target exposure area are reduced proportionally by the percent of the receptor home range they occupy. For example, if target Exposure Area A had an HQ for lead of 2 and comprised 60 percent of the receptor home range, and Exposure Areas B, C, and D each had HQs for lead of 0.9 and comprised 10 percent of the receptor home range, the spatially weighted HQ would be (2 x 0.6) + (0.9 x 0.1) + (0.9 x 0.1) +(0.9 x 0.1) + (0.9 x 0.1) = 1.56, compared to an HQ of 1.2 if Exposure Areas B, C, and D were assumed to contribute HQs of 0. Therefore, the spatially weighted HQs for large range receptors are recognized as having some uncertainty due to a slight non-conservative bias associated with this approach, but the uncertainty is not considered significant enough to warrant recalculation of HQs or affect the conclusions presented in this BERA.

Furthermore, any area within the foraging range of a large-range receptor that was outside of the Site boundary was not included in the spatially- weighted HQ calculation, effectively adding a dose of zero for that percentage of the home range outside the Site. This approach assumes that background levels contribute de minimus risk, which is consistent with the practice of excluding constituents detected on-site that are naturally occurring in the COPEC refinement step. In other words, if copper in soil within the exposure area was found to be background-related, it was not included in the wildlife ingestion model, which would essentially result in a dose of zero for copper in that exposure area. Therefore, both on- and off-site background-related risk was assumed to be negligible in this BERA and was not included in the wildlife ingestion modeling. The practice of assuming a dose of zero (rather than background) may slightly underestimate risk by not accounting for contributions from non-site related sources.

7.12 Incremental and Discrete Soil Sample Results in the Operational Area

As described in **Section 5.3.1**, both ISS and discrete soil samples were collected within the Operational Area, which overlaps portions of both the Main Plant and Central Landfills ecological exposure areas. The ISS samples were evaluated on an individual DU basis and used to evaluate potential impacts to sessile and small-range receptors, while the discrete samples were used in the exposure area-wide ingestion dose-response model that was used to evaluate receptors with a variety of home range sizes. Four DUs within the Operational Area grid were sampled in triplicate. RSDs calculated for each chemical and depth interval from these triplicate results were used to adjust the concentrations in the non-triplicate DUs to account for potential variability associated with the ISS samples (**Section 4.1.1.1)**. The high-adjusted concentrations were used in the screening-level and refined COPEC selection process (**Sections 4.3.2** and **4.5.2**), as well as the risk characterization for the Operational Area (**Section 6.3.1**). The range of mean RSDs used to adjust the non-triplicate DUs was 2.8 percent to 139 percent for the 0 to 0.5-ft bgs interval, and 1.9 to 98.2 percent for the 0.5 to 2 ft bgs interval. 20 of 60 mean RSDs used to adjust the concentrations in the 0 to 0.5-ft bgs interval exceeded 35 percent, and 31 of 62 in the 0.5 to 2 ft bgs interval exceeded 35 percent. Consistent with ITRC guidance (ITRC, 2012a), a criterion of 30 to 35 percent RSD in field replicates within the triplicate ISM DUs may indicate substantial heterogeneity in constituent concentrations within the DU. However, the fact that this criterion was exceeded for several individual and averaged RSD estimations did not materially affect risk conclusions in the BERA. Only one additional non-PAH SVOC was identified as a screening-level and refined COPEC using the high-adjusted dataset compared to the measured and low-adjusted datasets (**Appendices B** and **E**). The results of the risk characterization for the Incremental Sampling Grid (**Section 6.1.3**) were reviewed, and, although HQs were somewhat greater than if they had been based on the measured EPC dataset, the use of the high-adjusted values also did not materially affect results for the direct contact or small home range receptor evaluation (e.g., identification of additional site-related constituents with HQs > 1). Therefore, the variation within the triplicate results is noted as an uncertainty in the BERA, but the impacts on the BERA conclusions are minimal. Any impacts associated with this noted variation are conservative, as the high variance resulted in higher UCLs for the DUs with triplicate results, and in higher EPCs for the non-triplicate DUs, which collectively were used as the basis for COPEC selection and risk characterization.

A comparison was performed between the concentrations detected in ISS samples collected in the Main Plant Area and Central Landfills Area and the discrete soil samples that were collected within the ISS grid in these two ecological exposure areas to determine whether the discrete samples collected from these portions of the areas were appropriately representative of exposure to large-range receptors evaluated in the wildlife ingestion model.

The comparison between ISS and discrete sample concentrations was performed on constituents that were identified as refined COPECs for the Main Plant Area and Central Landfills Area (see COPEC refinement tables in **Appendix E**). Summary statistics, including detection frequency and the minimum, mean, and maximum detected concentrations, were compiled for the ISS samples (including both the 0-0.5 bgs and the 0.5-2 ft bgs sampling depths) and the discrete samples (0-2 feet bgs) that were nested within the ISS grid footprint in both exposure areas. The ISS results used for this comparison were the calculated 95 percent UCLs for DUs with triplicate results and the measured (i.e., unadjusted) concentrations from the DUs lacking triplicate results. The results are presented in **Table 7-2**. Box and whisker plots for select metals, other inorganic constituents (i.e., cyanide and fluoride), and PAHs are presented in **Figures 7-1, 7-2**, and **7-3**, respectively.

Most metals and both LMW and HMW PAHs had higher average concentrations in the ISS samples compared to the discrete samples that were collected within the ISS grid footprint compared to the discrete samples (**Table 7-2**; **Figures 7-1** and **7-3**). Cyanide and fluoride in the Main Plant Area, and fluoride in the Central Landfills Area also had higher mean concentrations in the ISS compared to discrete soil samples; although the mean concentration of cyanide in ISS samples was slightly lower than discrete samples, the median and overall distribution of cyanide concentrations was greater in the Central Landfills Area (**Table 7-2**; **Figure 7-2**) . Some of the differences were substantial; for example, copper, selenium, and zinc in the Main Plant Area, the mean concentration among the ISS samples was 4.8-, 5.5-, and 3.7-times the mean of the discrete samples. Copper, lead, and selenium in the Central Landfills Area had mean ISS concentrations more than twice as high as the discrete samples from the ISS grid footprint. Mean LMW and HMW PAHs ranged from 1.3 to 2-times higher in the ISS samples compared to the discrete samples across both exposure areas (**Table 7-2**).

The results of this evaluation indicate that the estimated doses for larger range receptors that were calculated using discrete samples may be somewhat underestimated in the portions of the Main Plant Area and Central Landfills Area that overlap the ISS grid. However, because this area comprises only a portion of most receptor home ranges, the impacts of this underestimation would be ameliorated by the remainder of the exposure area. A summary of the percentage of the home range of each terrestrial receptor that falls within the ISS grid for the Main Plant Area and Central Landfill Area is provided in the following table (note that the meadow vole and short-tailed shrew are small range receptors that are evaluated on a sample-by-sample basis for both ISS and discrete soil samples, and are not shown in the table):

Terrestrial receptor	**Home Range (acres)**	**# of Approx. 1-acre grids in Main Plant Area**	**% of Home Range**	**# of Approx. 1-acre grids in Central Landfill Area**	**% of Home Range**
American Woodcock	11.1	14	126%	29	261%
Mourning Dove	1986	14	1%	29	1%
Red-tailed Hawk	551	14	3%	29	5%
Yellow-billed Cuckoo	42	14	33%	29	69%
Canada Lynx	10625	14	0%	29	0%
Grizzly Bear	32000	14	0%	29	0%
Long-tailed Weasel	12	14	117%	29	242%
Wolverine	26000	14	0%	29	0%

Thus, the concern for underestimation of exposure to higher concentrations reflected by the ISS results compared to the discrete samples is minor for the mourning dove, red-tailed hawk, Canada lynx, grizzly bear, and wolverine, as the portion of their home range that is comprised of the ISS grid for their particular exposure areas is negligible. Concern is greater for the American woodcock and long-tailed weasel, both of which have home range sizes smaller than the area covered by the ISS grid in both exposure areas. The home range of the yellow-billed cuckoo substantially overlaps (33 and 69 percent) the ISS sampling grid in both exposure areas, as well.

This evaluation assumes that medium- and large-ranged receptors utilize a foraging area equal to the size of their home range and centered in the Main Plant or Central Landfills Area. The underestimation of risk may be greater for any receptors whose home ranges are centered on the Operational Area (rather than centered on the Main Plant Area or Central Landfills Area, for example). However, the Operational Area is one of the most industrially developed and disturbed areas of the Site, and the infrastructure and associated habitat degradation attributable to historical activities in this portion of the Site have resulted in low quality ecological resources that would likely be avoided by wildlife foraging in the area. The American woodcock represents avian insectivores, and some members of this foraging guild (e.g., the American robin) are tolerant of human presence and development, but a vast majority of the species represented by the American woodcock (avian insectivore) and long-tailed weasel (mammalian carnivore) are unlikely to regularly occur in the Operational Area. The yellow-billed cuckoo is a threatened species that is evaluated for individual protection rather as a representative of a specific foraging guild, but the presence of yellow-billed cuckoo is unlikely due to its rarity in Montana and, even if present in the vicinity of the Site, the usable habitat for the yellow-billed cuckoo is lacking in the Operational Area (see **Section 6.1.1.3** for additional discussion on the habitat requirements for this sensitive species). Therefore, the low likelihood for populations of larger ranging receptors to forage exclusively within the Operational Area is a moderating consideration for this portion of the Site.

The evaluation of the ISS samples on a point-by-point basis for small range receptors (i.e., the meadow vole and short-tailed shrew) reduces concern that ecological risks associated with exposure to the Operational Area are being underestimated, as these receptors typically are protective of larger ranging receptors owing to their small body size (toxicity and body size are generally inversely related because smaller sized animals need to consume more food relative to their body weight than larger animals) and localized exposure ranges. Larger range receptors typically occupy higher trophic order niches in the food chain and are therefore important to consider with regards to potential effects associated with bioaccumulation in the food chain. However, most metals and PAHs in terrestrial systems have relatively low bioaccumulation potential. Therefore, although risk associated with the constituents exhibiting higher concentrations in the ISS samples may be underestimated for larger-range receptors that incorporate part or all of the Operational Area into their home range, it is unlikely that the BERA conclusions are affected by this finding, and the list of constituents that potentially result in unacceptable risk using the point-by-point evaluation for small range receptors are most likely protective of larger-ranging receptors as well.

8 BERA Summary and Conclusions

The findings of the BERA are summarized to clearly identify the assessment procedures used, the potential risks identified, and the uncertainties associated with the conclusions. The BERA findings are evaluated for each ecological exposure area to support area-specific recommendations to guide risk management decision-making for the Site.

8.1 Terrestrial Exposure Areas

The overall results of the BERA for the terrestrial exposure areas are presented in **Table 8-1** and are summarized in this section.

8.1.1 Main Plant Area

Risk estimates for the Main Plant Area—particularly in the north-central portion of this exposure area--indicate the potential for adverse effects associated with exposure to PAHs in soil within localized portions of the Main Plant Area that are proximal to former operations. Direct contact exposure to PAHs in the Main Plant Area may potentially result in adverse effects to terrestrial invertebrates in these localized areas. PAHs were also responsible for two avian receptors (the American woodcock and yellow-billed cuckoo) having wildlife ingestion HQ_{LOAEL} values that exceeded 1, primarily due to the modeled ingestion of terrestrial invertebrates.

Based on these findings, the potential for ecological receptors to be adversely affected by constituents in soil in the Main Plant Area cannot be entirely dismissed under current conditions. However, concern regarding COPECs in the Main Plant Area is reduced because of the poor habitat available under current, developed conditions. Further evaluation of exposure to soils with elevated concentrations in the identified localized areas may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

8.1.2 Central Landfills Area

Risk estimates for the Central Landfills Area indicate the limited potential for adverse effects associated with direct contact to soil constituents. The direct contact risk evaluation performed at the Central Landfills exposure area indicates that potential risk to soil invertebrates and terrestrial plants is low, although localized areas of PAHs and one elevated copper result at CFSB-002 (7,260 mg/kg) resulted in some NOEC and LOEC exceedances. This sample had concentrations of copper that were an order of magnitude greater than the next highest detected concentration and two orders of magnitude greater than the mean in this exposure area. Therefore, this sample is considered anomalous, and the EPCs that were highly influenced by this anomalous sample resulted in risk estimates that far exceed what would be considered representative for the site as a whole. Wildlife ingestion models indicate the potential for adverse effects associated with exposure to copper, PAHs, and Aroclor 1254 assuming conservative exposure assumptions. The modeled ingestion of terrestrial invertebrate prey items was the critical exposure pathway for all COPECs and receptors. Similar to the direct contact pathways, EPCs for copper are driven by an anomalously high concentration at a single station. An EPC for copper calculated with the anomalous concentration excluded resulted in negligible risks for wildlife receptors. EPCs for PAHs were also influenced by localized stations with elevated concentrations. The small range receptor evaluation indicated several sample locations (e.g., CFLP-009, CFSB-004, CFLP-012, CFSB-227, CFSB-224) with concentrations exceeding the LOAEL-based soil benchmarks for the short-tailed shrew in the area where the Wet Scrubber Sludge Pond was formerly located and in the southern portion of the exposure area between the Wet Scrubber Sludge Pond and the Main Plant Area.

Based on these findings, the potential for ecological receptors to be adversely affected by constituents in soil in the Central Landfills Area cannot be entirely dismissed under current conditions. However, concern regarding COPECs in the Central Landfills Area is reduced because of the poor habitat available under current, developed conditions. Further evaluation of exposure to soils with elevated concentrations in the identified localized areas may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

8.1.3 Incremental Soil Sampling Grid

Risk estimates for the ISS Grid were similar to risk estimates for overlapping areas within the Main Plant Area and Central Landfills Area. Direct contact resulted in moderate risk to soil invertebrates and plants based on contact with PAHs and select metals, including copper, selenium (plants only) and zinc. Several of the DUs, particularly in the central third of the ISS Grid within the Central Landfills Area, had concentrations of constituents that exceeded LOAEL-based benchmarks protective of small range receptors. Exceedances of LOAEL-based benchmarks in these DUs were primarily associated with LMW and HMW PAH exposure to short-tailed shrew.

Based on these findings, the potential for ecological receptors to be adversely affected by constituents in soil in some ISS grids cannot be entirely dismissed under current conditions. However, concern regarding COPECs in the Operational Area where the ISS grids were located is reduced because of the poor habitat available under current, developed conditions. Further evaluation of exposure to soils with elevated concentrations in the identified localized areas may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

8.1.4 Industrial Landfill Area

Risk estimates for the Industrial Landfill Area indicate minimal potential for adverse effects associated with exposure to constituents in soil. The results of the food chain model indicated that nickel (American woodcock and short-tailed shrew) and HMW PAHs (American woodcock and yellow-billed cuckoo) had HQ_{LOAEL} values that exceeded 1 in this exposure area, primarily due to the modeled ingestion of terrestrial invertebrate prey items. All HQ_{LOAEL} values were less than 5, however. Therefore, nickel and PAHs in soil at the Industrial Landfills Area represent a moderate risk to ecological receptors due to exposure from direct and indirect ingestion pathways.

Based on these findings, the potential for ecological receptors to be adversely affected by constituents in soil in the Industrial Landfill Area cannot be entirely dismissed under current conditions. However, concern regarding COPECs in the Industrial Landfill Area is reduced because of the poor habitat available under current, developed conditions. Further evaluation of exposure to soils with elevated concentrations in the identified localized areas may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

8.1.5 Eastern Undeveloped Area

Risk estimates for the Eastern Undeveloped Area indicate negligible potential for adverse effects associated with exposure to soil. No further evaluation to assess the potential for ecological risk is warranted in this exposure area.

8.1.6 North-Central Undeveloped Area

Risk estimates for the North-Central Undeveloped Area indicate negligible potential for adverse effects associated with exposure to soil. No further evaluation to assess the potential for ecological risk is warranted in this exposure area.

8.1.7 Western Undeveloped Area

Risk estimates for the Western Undeveloped Area indicate negligible potential for adverse effects associated with exposure to soil. No further evaluation to assess the potential for ecological risk is warranted in this exposure area.

8.1.8 Flathead River Riparian Area

Risk estimates for the Flathead River Riparian Area indicate negligible potential for adverse effects associated with exposure to soil. No further evaluation to assess the potential for ecological risk is warranted in this exposure area.

8.2 Transitional Exposure Areas

The overall results of the BERA for the transitional exposure areas are presented in **Table 8-2** (terrestrial evaluation) and **Table 8-3** (aquatic evaluation) and are summarized in this section.

8.2.1 North Percolation Pond Area

Elevated risks associated with direct contact to aquatic and terrestrial plants and invertebrates, and to multiple wildlife receptors foraging on benthic and terrestrial invertebrates were present in the North Percolation Ponds. Concentrations were present in every soil sample that exceeded the LOAEL benchmark protective of small-range receptors. Cyanide and several metals (e.g., barium, nickel, selenium, and vanadium) and PAHs were responsible for this elevated risk. The greatest potential for adverse effects was attributable to the North-East Percolation Pond.

Further actions should be considered to reduce or further study the elevated ecological risk at this exposure area. Further risk assessment may not be beneficial, particularly in the North-East Pond until the future uses of the North Percolation Pond are determined.

8.2.2 South Percolation Pond Area

The potential for adverse effects associated with constituents in media at the South Percolation Pond Area is considered minimal under dry scenarios, but moderate under inundated scenarios due to potential adverse effects associated with direct contact with cyanide, metals, and PAHs in surface water. One potential action that could address this elevated risk is to evaluate the potential for minimizing stormwater discharge with elevated concentrations of cyanide, aluminum, and other COPECs to the South Percolation Ponds.

8.2.3 Cedar Creek Reservoir Overflow Ditch

The potential for adverse effects associated with constituents in media at the Cedar Creek Reservoir Overflow Ditch Area is considered minimal under both dry and inundated scenarios. No further evaluation to assess the potential for ecological risk is warranted in this exposure area.

8.2.4 Northern Surface Water Feature

The potential for adverse effects associated with constituents in media at the Northern Surface Water Feature Area is considered minimal under both dry and inundated scenarios. No further evaluation to assess the potential for ecological risk is warranted in this exposure area.

8.3 Aquatic Exposure Areas

The overall results of the BERA for the aquatic exposure areas are presented in **Table 8-4** and are summarized in this section.

8.3.1 Flathead River

Elevated risk associated with direct contact to aquatic receptors was noted within the Backwater Seep Sampling Area/Flathead River Riparian Channel, and was greatest for cyanide, barium, and aluminum in surface water and pore water. Ecological risk associated with direct contact within this limited area was considered moderate. However, rapid attenuation with increasing distance from the seep area was noted, and the potential for ecological risk in the main channel of the Flathead River for both direct contact and wildlife ingestion pathways was considered minimal and negligible, respectively. Further evaluation of chronic, direct contact exposure to cyanide in surface water and pore water in the Backwater Seep Sampling Area/Flathead River Riparian Channel may be warranted.

8.3.2 Cedar Creek

Potential risks associated with direct contact with surface water and sediment in Cedar Creek are negligible. No further evaluation to assess the potential for ecological risk is warranted in this exposure area.

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Tables

Table 3-1
Qualitative Assessment of Habitat Use by Representative Receptors
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	Habitat Description[1]	Habitat Use Ranks[2,3]								
		American Dipper	American Woodcock	Belted Kingfisher	Mourning Dove	Yellow-Billed Cuckoo	Canada Lynx	Grizzly Bear	Meadow Vole	Short-tailed Shrew
Terrestrial Exposure Areas										
Main Plant Area (231.9 acres)	Limited habitat quality due to former plant operations; characterized by early successional, non-woody vegetation and compacted soil; infrastructure related to former operations.	NA	1*	NA	3	1	1	1	4	3
Central Landfills Area (44.4 acres)	Limited habitat quality due to former plant operations; characterized by early successional, non-woody vegetation and compacted soil. Highest quality habitat at eastern boundary of exposure area.	NA	1*	NA	3	1	1	1	4	3
Industrial Landfill Area (12.6 acres)	Inactive, uncapped landfill. Reduced habitat quality due to landfill maintenance; characterized by early successional, non-woody vegetation.	NA	2*	NA	4	1	2	2	4	3
Eastern Undeveloped Area (64.9 acres)	Mix montane mixed conifer forest and lower montane grassland; montane-foothill deciduous shrubland located to the northeast and east of the Main Plant Area. Used by multiple avian and mammalian terrestrial receptor guilds.	NA	3	NA	4	2	2	3	5	4
North-Central Undeveloped Area (114.4 acres)	Mix montane mixed conifer forest and lower montane grassland; used by multiple avian and mammalian terrestrial receptor guilds.	NA	3	NA	4	2	2	3	5	4
Western Undeveloped Area (439.6 acres)	Mix montane mixed conifer forest and lower montane grassland; riparian woodland habitat dominated by cottonwood (*Populus spp.*) borders Cedar Creek. Used by multiple avian and mammalian receptor guilds.	NA	3	NA	4	2	2	3	5	4
Flathead River Riparian Area (93.9 acres)	Riparian woodland habitat dominated by cottonwood (*Populus spp.*), boxelder (*Acer negundo*), quaking aspen (*Populus tremloides*), and paper birch (*Betula papyrifera*). Maintained utility corridor. Used by multiple terrestrial and semi-aquatic avian and mammalian receptor guilds.	NA	4	NA	4	2	2	3	5	5
Transitional Exposure Areas										
Cedar Creek Reservoir Overflow Ditch (5.2 acres)	Intermittent surface water conveyance controlled by surface water discharge from the Cedar Creek Reservoir.	1	1*	1	2	1	1	1	1	1
South Percolation Pond Area (5.6 acres)	Three interconnected former process ponds located adjacent to the Flathead River; currently only stormwater discharges to the ponds. Variable hydrology from complete inundation during wet season to limited inundation during the dry season. Potential seasonal habitat for amphibians and tolerant invertebrates.	1*	2*	3	3	1	1	2	2	2
Northern Surface Water Feature (6.1 acres)	Seasonally and interannually variable surface water feature fed by groundwater discharge; potential temporary habitat for amphibians and tolerant invertebrates.	1*	3	2	3	2	2	3	4	4
North Percolation Pond Area (11.3 acres)	Two interconnected former process ponds; currently receives stormwater discharge. Variable hydrology related to stormwater discharge; not inundated during the dry season. Potential seasonal habitat for amphibians and tolerant invertebrates.	1*	1*	1	2	1	1	1	2	2
Aquatic Exposure Areas										
Flathead River	Coldwater river that supports the growth and propagation of salmonid fishes and associate aquatic life; fisheries near the Site are fairly limited by sub-optimal stream channel habitat.	3	NA	4	NA	NA	NA	NA	NA	NA
Cedar Creek	Second order tributary to the Flathead River; coldwater habitat that likely supports fish, however, small channel size limits biomass of edible sized fish.	4	NA	5	NA	NA	NA	NA	NA	NA

Notes:
1, Habitat descriptions summarized based on the habitat assessment reported in the *Screening Level Ecological Risk Assessment* (Roux, 2017b).
2, Habitat Use Ranks:
1. Little to no habitat available at the exposure area for the receptor or surrogates; regular exposure to populations (or individual organisms, for sensitive species) highly unlikely.
2. Low quality habitat for the species is available in portions of the site, but regular exposure to populations (or individual organisms, for sensitive species) is not be expected. Low probability for receptor to be present regionally.
3. Habitat quality is moderate for receptor. Regular exposure to receptor at the site is possible, but risk estimates based on 100 percent exposure are likely overestimated.
4. Significant portions of the exposure area have habitat qualities favored by the receptor; the assumption that the receptor could be exposed to a majority of the site area is reasonable.
5. Habitat is ideal (or nearly ideal) for the species.

NA, Habitat is not applicable for the listed receptor.
3, An asterisk (*) indicates that although it is highly unlikely that the receptor species in question would use the site, other species in its foraging guild that it represents may utilize the area to some extent.

Receptor	Habitat Requirements
American Dipper:	Prefers fast-moving, clear streams along with waterfalls. Species prefers sand, pebble, or rocky stream bottoms, which provide sufficient aquatic invertebrates. Shorelines with large boulders, fallen trees, and rubble provide shelter and protection from predators (1.).
American Woodcock:	The woodcock is primarily found in the eastern U.S. There has only been a single record in the Montana in the past 10 years (1.). Hides in forest thickets by day, where it uses its long bill to probe in damp soil for earthworms (2.).
Belted Kingfisher:	Inhabits streams, rivers, ponds, lakes, and estuaries or calm marine waters in which prey are clearly visible. Availability of suitable nesting sites - earthen banks where nesting burrows can be excavated - appears critical for the distribution and local abundance of this species (1.).
Mourning Dove:	Species has tremendous adaptability. Generally shuns deep woods or extensive forest and selects more open woodlands and edges between forest and prairie biomes for nesting. Human alteration of original vegetations is generally beneficial for this species (1.).
Yellow-Billed Cuckoo:	Rarely observed in Montana. Requires dense, wooded habitats with cover and water nearby, particularly cottonwood-dominated forests canopies (Hughes, 2015; MNHP, 2019). Western subspecies require patches of at least 10 hectares (25 acres) of dense, riparian forest with a canopy cover of at least 50 percent in both the understory and overstory. The Yellow-billed Cuckoo is known in Montana only in June and July. All of these observations indicate no behavioral evidence to suggest breeding (1.).
Canada Lynx:	Moist, boreal spruce-fir forest habitat, particularly dense stands of young conifers. In northwestern Montana, primary vegetation may include cedar-hemlock habitat types (1.).
Grizzly Bear:	Relatively undisturbed mountainous habitat ranging from dense forest to subalpine meadows. In Montana, primarily meadows, seeps, riparian zones, mixed shrub fields, open timber, closed timber. Habitat use is highly variable between areas and seasons (1.).
Meadow Vole:	Wet grassland habitat but not above timberline in grassy alpine tundra. *M. pennsylvanicus* may inhabit drier grasslands than *M. montanus* (1.).
Short-tailed Shrew:	Most common in hardwood forests with deep leaf litter and in brushy sites adjacent to ponds and streams, less common in conifer forest and grassland (1.).

Sources:
1. Montana Field Guides online, http://fieldguide.mt.gov/speciesDetail.aspx?elcode=ABPBH01010
2. Audubon Guide to North American Birds online, https://www.audubon.org/bird-guide

Table 4-1
Samples Used in the Baseline Ecological Risk Assessment - Main Plant Area
Main Plant Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples (Incremental Samples)				
CFISS-030	CFISS-030-SO-0-0.5	25-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-030	CFISS-030-SO-0.5-2	25-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-031	CFISS-031-S0-0-0.5	13-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-031	CFISS-031-S0-0.5-2	13-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-032	CFISS-032-SO-0-0.5	12-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-032	CFISS-032-SO-0.5-2	12-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-033	CFISS-033-SO-0-0.5	12-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-033	CFISS-033-SO-0.5-2	12-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-034	CFISS-034-SO-0-0.5	11-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-034	CFISS-034-SO-0.5-2	11-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-035	CFISS-035-SO-0-0.5	11-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-035	CFISS-035-SO-0.5-2	11-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-036	CFISS-036-SO-0-0.5	15-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-036	CFISS-036-SO-0.5-2	15-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-037	CFISS-037-SO-0-0.5	15-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-037	CFISS-037-SO-0.5-2	15-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-038	CFISS-038-S0-0-0.5	14-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-038	CFISS-038-S0-0.5-2	14-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-039	CFISS-039-S0-0-0.5	14-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-039	CFISS-039-S0-0.5-2	14-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-040	CFISS-040-S0-0-0.5	13-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-040	CFISS-040-S0-0.5-2	13-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-041	CFISS-41-SO-0-0.5	16-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-041	CFISS-41-SO-0.5-2	16-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-042	CFISS-042-SO-0-0.5	18-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-042	CFISS-042-SO-0.5-2	18-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-043	CFISS-043-SO-0-0.5	18-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-043	CFISS-043-SO-0.5-2	18-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
Soil Samples (Grab Samples)				
CFMW-028A	CFMW-028a-SO-0-0.5	30-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-028A	CFMW-028a-SO-0.5-2	30-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-032A	CFMW-032a-SO-0-0.5	8-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-032A	CFMW-032a-SO-0.5-2	8-Aug-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-033	CFMW-033-SO-0-0.5	1-Jul-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFMW-033	CFMW-033-SO-0.5-2	1-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-034	CFMW-034-SO-0-0.5	31-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-034	CFMW-034-SO-0.5-2	31-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-035	CFMW-035-SO-0-0.5	1-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-035	CFMW-035-SO-0.5-2	1-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-037	CFMW-037-SO-0-0.5	24-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-037	CFMW-037-SO-0.5-2	24-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-038	CFMW-038-SO-0-0.5	25-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-038	CFMW-038-SO-0.5-2	25-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-040	CFMW-040-SO-0-0.5	28-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-040	CFMW-040-SO-0.5-2	28-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-042	CFMW-042-SO-0-0.5	16-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-042	CFMW-042-SO-0.5-2	16-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-043	CFMW-043-SO-0-0.5	15-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-043	CFMW-043-SO-0.5-2	15-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-044A	CFMW-044a-SO-0-0.5	20-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs

Table 4-1
Samples Used in the Baseline Ecological Risk Assessment - Main Plant Area
Main Plant Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFMW-044A	CFMW-044a-SO-0.5-2	20-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-045A	CFMW-045a-SO-0-0.5	12-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-045A	CFMW-045a-SO-0.5-2	12-Aug-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-047	CFMW-047-SO-0-0.5	21-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-047	CFMW-047-SO-0.5-2	21-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-049	CFMW-049-SO-0-0.5	20-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-049A	CFMW-049a-SO-0.5-2	20-Aug-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-050	CFMW-050-SO-0-0.5	22-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-050	CFMW-050-SO-0.5-2	22-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-053A	CFMW-053a-SO-0-0.5	17-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-053A	CFMW-053a-SO-0.5-2	17-Aug-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-054	CFMW-054-SO-0-0.5	20-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-054	CFMW-054-SO-0.5-2	20-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-070	CFMW-070-SO-0-0.5	16-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFMW-070	CFMW-070-SO-0.5-2	16-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-010	CFSB-010-SO-0.5-2	21-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-012	CFSB-012-SO-0.5-2	28-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-038	CFSB-038-SO-0-0.5	21-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-038	CFSB-038-SO-0.5-2	21-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-040	CFSB-040-SO-0-0.5	20-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-040	CFSB-040-SO-0.5-2	20-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-042	CFSB-042-SO-0-0.5	20-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-042	CFSB-042-SO-0.5-2	20-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-044	CFSB-044-SO-0-0.5	20-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-044	CFSB-044-SO-0.5-2.0	20-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-045	CFSB-045-SO-0-0.5	21-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-045	CFSB-045-SO-0.5-2	21-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-046	CFSB-046-SO-0-0.5	20-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-046	CFSB-046-SO-0.5-2.0	20-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-048	CFSB-048-SO-0-0.5	20-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-048	CFSB-048-SO-0.5-2.0	20-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-049	CFSB-049-SO-0.5-2	28-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-050	CFSB-050-SO-0-0.5	21-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-050	CFSB-050-SO-0.5-2	21-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-051	CFSB-051-SO-0-0.5	21-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-051	CFSB-051-SO-0.5-2	21-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-052	CFSB-052-SO-0.5-2	20-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-053	CFSB-053-SO-0.5-2	31-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-054	CFSB-054-SO-0-0.5	28-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-054	CFSB-054-SO-0.5-2	28-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-055	CFSB-055-SO-0-0.5	28-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-055	CFSB-055-SO-0.5-2	28-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-057	CFSB-057-SO-0-0.5	28-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-057	CFSB-057-SO-0.5-2	28-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-059	CFSB-059-SO-0-0.5	28-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-059	CFSB-059-SO-0.5-2	28-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-060	CFSB-060-SO-0-0.5	27-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-060	CFSB-060-SO-0.5-2	27-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-062	CFSB-062-SO-0-0.5	2-Jun-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-062	CFSB-062-SO-0.5-2	2-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-064	CFSB-064-SO-0-0.5	3-Jun-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs

Table 4-1
Samples Used in the Baseline Ecological Risk Assessment - Main Plant Area
Main Plant Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSB-064	CFSB-064-SO-0.5-2	3-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-065	CFSB-065-SO-0-0.5	2-Jun-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-065	CFSB-065-SO-0.5-2	2-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-066	CFSB-066-SO-0-0.5	27-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-066	CFSB-066-SO-0.5-2	27-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-068	CFSB-068-SO-0.5-2	27-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-069	CFSB-069-SO-0-0.5	27-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-069	CFSB-069-SO-0.5-2	27-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-071	CFSB-071-SO-0-0.5	27-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-071	CFSB-071-SO-0.5-2	27-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-073	CFSB-073-SO-0-0.5	1-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-073	CFSB-073-SO-0.5-2	1-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-074	CFSB-074-SO-0-0.5	1-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-074	CFSB-074-SO-0.5-2	1-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-075	CFSB-075-SO-0-0.5	1-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-075	CFSB-075-SO-0.5-2	1-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-079	CFSB-079-SO-0-0.5	1-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-079	CFSB-079-SO-0.5-2	1-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-080	CFSB-080-SO-0-0.5	1-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-080	CFSB-080-SO-0.5-2	1-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-082	CFSB-082-SO-0-0.5	1-Jun-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-082	CFSB-082-SO-0.5-2	1-Jun-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-084	CFSB-084-SO-0-0.5	27-May-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-084	CFSB-084-SO-0.5-2	27-May-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-086	CFSB-086-SO-0-0.5	26-May-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-086	CFSB-086-SO-0.5-2	26-May-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-087	CFSB-087-SO-0-0.5	26-May-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-087	CFSB-087-SO-0.5-2	26-May-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-088	CFSB-088-SO-0-0.5	26-May-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-088	CFSB-088-SO-0.5-2	26-May-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-092	CFSB-092-SO-0-0.5	26-May-16	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-092	CFSB-092-SO-0.5-2	26-May-16	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-094	CFSB-094-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-094	CFSB-094-SO-0.5-2.0	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-095	CFSB-095-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-095	CFSB-095-SO-0.5-2.0	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-097	CFSB-097-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-097	CFSB-097-SO-0.5-2	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-098	CFSB-098-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-098	CFSB-098-SO-0.5-2	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-099	CFSB-099-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-099	CFSB-099-SO-0.5-2	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-100	CFSB-100-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-100	CFSB-100-SO-0.5-2	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-128	CFSB-128-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-128	CFSB-128-SO-0.5-2.0	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-129	CFSB-129-SO-0-0.5	24-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-129	CFSB-129-SO-0.5-2.0	24-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-130	CFSB-130-SO-0.5-2	17-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-131	CFSB-131-SO-0.5-2	17-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-154	CFSB-154-SO-0.5-2.5	15-May-18	0.5 - 2.5	Gen Chem, Metals, SVOCs, VOCs

Table 4-1
Samples Used in the Baseline Ecological Risk Assessment - Main Plant Area
Main Plant Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSB-155	CFSB-155-SO-0.5-2.5	15-May-18	0.5 - 2.5	Gen Chem, Metals, SVOCs, VOCs
CFSB-156	CFSB-156-SO-0.5-2.5	15-May-18	0.5 - 2.5	Gen Chem, Metals, SVOCs, VOCs
CFSB-157	CFSB-157-SO-0.5-2.5	12-May-18	0.5 - 2.5	Gen Chem, Metals, SVOCs, VOCs
CFSB-158	CFSB-158-SO-0.5-2.5	12-May-18	1.5 - 2.5	Gen Chem, Metals, SVOCs, VOCs
CFSB-161	CFSB-161-SO-0.5-2.5	12-May-18	0.5 - 2.5	Gen Chem, Metals, SVOCs, VOCs
CFSB-162	CFSB-162-SO-0.5-2.5	12-May-18	0.5 - 2.5	Gen Chem, Metals, SVOCs, VOCs
CFSB-167	CFSB-167-SO-1-3	15-May-18	1 - 3	Gen Chem, Metals, SVOCs, VOCs
CFSB-189	CFSB-189-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, Hex Chrom, SVOCs
CFSB-189	CFSB-189-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-189	CFSB-189-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, Hex Chrom, SVOCs
CFSB-189	CFSB-189-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-190	CFSB-190-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-190	CFSB-190-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-190	CFSB-190-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-190	CFSB-190-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-205	CFSB-205-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, Hex Chrom, SVOCs
CFSB-205	CFSB-205-SO-0-0.5	26-Sep-18	0 - 0.5	Dioxins
CFSB-205	CFSB-205-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, Hex Chrom, SVOCs
CFSB-205	CFSB-205-SO-0.5-2	26-Sep-18	0.5 - 2	Dioxins
CFSB-206	CFSB-206-SO-0-0.5	22-Jun-18	0 - 0.5	Dioxins, Gen Chem, Metals, SVOCs
CFSB-206	CFSB-206-SO-0.5-2	22-Jun-18	0.5 - 2	Dioxins, Gen Chem, Metals, SVOCs
CFSB-207	CFSB-207-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-207	CFSB-207-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-208	CFSB-208-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-208	CFSB-208-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, Gen Chem, Metals, PCBs, SVOCs
CFSB-213	CFSB-213-SO-0-0.5	22-Jun-18	0 - 0.5	Dioxins, Gen Chem, Metals, SVOCs
CFSB-213	CFSB-213-SO-0.5-2	22-Jun-18	0.5 - 2	Dioxins, Gen Chem, Metals, SVOCs
CFSB-231	CFSB-231-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, PCBs
CFSB-231	CFSB-231-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, PCBs
CFSB-232	CFSB-232-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, PCBs
CFSB-232	CFSB-232-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, PCBs
CFSB-233	CFSB-233-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, PCBs
CFSB-233	CFSB-233-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, PCBs
CFSB-234	CFSB-234-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, PCBs
CFSB-234	CFSB-234-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, PCBs
CFSB-235	CFSB-235-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, PCBs
CFSB-235	CFSB-235-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, PCBs
CFSB-236	CFSB-236-SO-0-0.5	28-Apr-18	0 - 0.5	Dioxins, PCBs
CFSB-236	CFSB-236-SO-0.5-2	28-Apr-18	0.5 - 2	Dioxins, PCBs
CFSB-240	CFSB-240-SO-0-0.5	10-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-240	CFSB-240-SO-0.5-2	10-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-242	CFSB-242-SO-0-0.5	10-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-242	CFSB-242-SO-0.5-2	10-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-243	CFSB-243-SO-0-0.5	10-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-243	CFSB-243-SO-0.5-2	10-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-266	CFSB-266-SO-0-0.5	10-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-266	CFSB-266-SO-0.5-2	10-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-274	CFSB-274-SO-0-0.5	11-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-274	CFSB-274-SO-0-0.5	28-Sep-18	0 - 0.5	Gen Chem
CFSB-274	CFSB-274-SO-0.5-2	11-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-274	CFSB-274-SO-0.5-2	28-Sep-18	0.5 - 2	Gen Chem

Table 4-1
Samples Used in the Baseline Ecological Risk Assessment - Main Plant Area
Main Plant Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSB-275	CFSB-275-SO-0-0.5	11-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-275	CFSB-275-SO-0-0.5	28-Sep-18	0 - 0.5	Gen Chem
CFSB-275	CFSB-275-SO-0.5-2	11-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-275	CFSB-275-SO-0.5-2	28-Sep-18	0.5 - 2	Gen Chem
CFSB-276	CFSB-276-SO-0-0.5	11-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-276	CFSB-276-SO-0-0.5	28-Sep-18	0 - 0.5	Gen Chem
CFSB-276	CFSB-276-SO-0.5-2	11-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-276	CFSB-276-SO-0.5-2	28-Sep-18	0.5 - 2	Gen Chem
CFSB-278	CFSB-278-SO-0-0.5	11-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-278	CFSB-278-SO-0-0.5	28-Sep-18	0 - 0.5	Gen Chem
CFSB-278	CFSB-278-SO-0.5-2	11-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-278	CFSB-278-SO-0.5-2	28-Sep-18	0.5 - 2	Gen Chem
CFSB-288	CFSB-288-SO-0-0.5	28-Jun-18	0 - 0.5	Metals, Hex Chrom
CFSB-288	CFSB-288-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-288	CFSB-288-SO-0.5-2	28-Jun-18	0.5 - 2	Metals, Hex Chrom
CFSB-288	CFSB-288-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-293	CFSB-293-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-293	CFSB-293-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-294	CFSB-294-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-294	CFSB-294-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins

Notes:
Gen Chem: general chemistry parameters
Hex Chrom: hexavalent chromium
PCBs: polychlorinated biphenyls
SVOCs: semivolatile organic compounds
VOCs: volatile organic compounds

Table 4-2
Samples Used in the Baseline Ecological Risk Assessment - Central Landfills Area
Central Landfills Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples (Incremental Soil Samples)				
CFISS-001[a]	CFISS-01-S0-0-0.5	23-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-001[a]	CFISS-01-S0-0.5-2	23-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-002	CFISS-002-SO-0-0.5	19-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-002	CFISS-002-SO-0.5-2	19-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-003	CFISS-03-SO-0-0.5	22-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-003	CFISS-03-SO-0.5-2	22-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-004[a]	CFISS-04-SO-0-0.5	19-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-004[a]	CFISS-04-SO-0.5-2	19-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-005	CFISS-05-SO-0-0.5	22-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-005	CFISS-05-SO-0.5-2	22-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-006	CFISS-006-SO-0-0.5	19-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-006	CFISS-006-SO-0.5-2	19-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-007	CFISS-07-SO-0-0.5	17-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-007	CFISS-07-SO-0.5-2	17-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-008	CFISS-008-SO-0-0.5	26-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-008	CFISS-008-SO-0.5-2	26-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-009	CFISS-09-SO-0-0.5	21-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-009	CFISS-09-SO-0.5-2	21-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-010	CFISS-010-SO-0-0.5	21-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-010	CFISS-010-SO-0.5-2	21-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-011[a]	CFISS-011-SO-0.0-0.5	19-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-011[a]	CFISS-011-SO-0.5-2	19-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-012	CFISS-012-0.0-0.5	18-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-012	CFISS-012-0.5-2	18-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-013	CFISS-013-SO-0-0.5	17-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-013	CFISS-013-SO-0.5-2	17-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-014	CFISS-014-SO-0-0.5	16-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-014	CFISS-014-SO-0.5-2	16-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-015[a]	CFISS-015-SO-0-0.5	15-May-18	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-015[a]	CFISS-015-SO-0.5-2	15-May-18	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-016	CFISS-016-SO-0-0.5	23-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-016	CFISS-016-SO-0.5-2	28-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-017	CFISS-017-SO-0-0.5	29-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-017	CFISS-017-SO-0.5-2	23-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-018	CFISS-018-SO-0-0.5	24-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-018	CFISS-018-SO-0.5-2	24-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-019	CFISS-019-SO-0-0.5	24-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-019	CFISS-019-SO-0.5-2	24-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-020	CFISS-020-SO-0-0.5	25-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-020	CFISS-020-SO-0.5-2	25-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-021	CFISS-021-SO-0-0.5	25-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-021	CFISS-021-SO-0.5-2	25-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-022	CFISS-022-SO-0-0.5	27-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-022	CFISS-022-SO-0.5-2	27-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-023	CFISS-023-SO-0-0.5	27-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-023	CFISS-023-SO-0.5-2	27-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-024	CFISS-024-SO-0-0.5	29-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-024	CFISS-024-SO-0.5-2	29-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-025	CFISS-025-SO-0-0.5	30-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs

Table 4-2
Samples Used in the Baseline Ecological Risk Assessment - Central Landfills Area
Central Landfills Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFISS-025	CFISS-025-SO-0.5-2	30-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-026	CFISS-026-SO-0-0.5	30-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-026	CFISS-026-SO-0.5-2	30-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-027	CFISS-027-SO-0-0.5	1-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-027	CFISS-027-SO-0.5-2	1-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-028	CFISS-028-SO-0-0.5	1-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-028	CFISS-028-SO-0.5-2	1-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
CFISS-029	CFISS-029-SO-0-0.5	27-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFISS-029	CFISS-029-SO-0.5-2	27-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs
Soil Samples (Grab Soil Samples)				
CFLP-007	CFLP-007-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-007	CFLP-007-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-008	CFLP-008-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-008	CFLP-008-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-009	CFLP-009-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-009	CFLP-009-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-010	CFLP-010-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-010	CFLP-010-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-011	CFLP-011-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-011	CFLP-011-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-012	CFLP-012-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-012	CFLP-012-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-013	CFLP-013-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-013	CFLP-013-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-014	CFLP-014-SO-0-0.5	9-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-014	CFLP-014-SO-0.5-2	9-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-015	CFLP-015-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-015	CFLP-015-SO-0.5-2	16-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-016	CFLP-016-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-016	CFLP-016-SO-0.5-2	16-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-017	CFLP-017-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-017	CFLP-017-SO-0.5-2	16-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-018	CFLP-018-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-018	CFLP-018-SO-0.5-2	16-Jun-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFMW-002	CFMW-002-SO-0-0.5	13-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-002	CFMW-002-SO-0.5-2	13-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-008A	CFMW-008a-SO-0-0.5	13-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-008A	CFMW-008a-SO-0.5-2	13-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-010	CFMW-010-SO-0-0.5	18-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-010	CFMW-010-SO-0.5-2.0	18-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-012A	CFMW-012A-SO-0-0.5	20-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-012A	CFMW-012A-SO-0.5-2	20-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-016A	CFMW-016a-SO-0-0.5	21-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-016A	CFMW-016a-SO-0.5-2	21-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-018	CFMW-018-SO-0-0.5	19-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-018	CFMW-018-SO-0.5-2.0	19-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-019A	CFMW-019a-SO-0-0.5	25-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-019A	CFMW-019a-SO-0.5-2	25-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-022	CFMW-022-SO-0-0.5	2-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-022	CFMW-022-SO-0.5-2	2-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs

Table 4-2
Samples Used in the Baseline Ecological Risk Assessment - Central Landfills Area
Central Landfills Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFMW-023A	CFMW-023a-SO-0-0.5	17-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-023A	CFMW-023a-SO-0.5-2	17-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-029	CFMW-029-SO-0-0.5	18-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-029	CFMW-029-SO-0.5-2.0	18-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-001	CFSB-001-SO-0-0.5	25-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-001	CFSB-001-SO-0.5-2	25-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-002	CFSB-002-SO-0-0.5	25-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-002	CFSB-002-SO-0.5-2	25-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-003	CFSB-003-SO-0-0.5	25-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-003	CFSB-003-SO-0.5-2	25-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-004	CFSB-004-SO-0-0.5	25-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-004	CFSB-004-SO-0.5-2	25-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-005	CFSB-005-SO-0-0.5	25-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-005	CFSB-005-SO-0.5-2	25-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-006	CFSB-006-SO-0-0.5	23-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-006	CFSB-006-SO-0.5-2	23-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-007	CFSB-007-SO-0-0.5	25-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-007	CFSB-007-SO-0.5-2	25-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-008	CFSB-008-SO-0-0.5	23-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-008	CFSB-008-SO-0.5-2	23-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-009	CFSB-009-SO-0-0.5	23-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-009	CFSB-009-SO-0.5-2	23-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-021	CFSB-021-SO-0-0.5	23-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-021	CFSB-021-SO-0.5-2	23-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-022	CFSB-022-SO-0-0.5	23-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-022	CFSB-022-SO-0.5-2	23-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-029	CFSB-029-SO-0-0.5	23-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-029	CFSB-029-SO-0.5-2	23-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-033	CFSB-033-SO-0-0.5	23-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-033	CFSB-033-SO-0.5-2	23-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-034	CFSB-034-SO-0-0.5	31-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-034	CFSB-034-SO-0.5-2	31-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-035	CFSB-035-SO-0-0.5	31-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-035	CFSB-035-SO-0.5-2	31-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-036	CFSB-036-SO-0-0.5	31-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-036	CFSB-036-SO-0.5-2	31-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-037	CFSB-037-SO-0-0.5	31-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-037	CFSB-037-SO-0.5-2	31-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-177	CFSB-177-SO-0-0.5	25-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-177	CFSB-177-SO-0.5-2	25-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-178	CFSB-178-SO-0-0.5	25-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-178	CFSB-178-SO-0.5-2	25-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-179	CFSB-179-SO-0-0.5	25-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-179	CFSB-179-SO-0.5-2	25-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-180	CFSB-180-SO-0-0.5	25-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-180	CFSB-180-SO-0.5-2	25-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-219	CFSB-219-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-219	CFSB-219-SO-0.5-2	16-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-220	CFSB-220-SO-0-0.5	22-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-220	CFSB-220-SO-0.5-2	22-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs

Table 4-2
Samples Used in the Baseline Ecological Risk Assessment - Central Landfills Area
Central Landfills Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSB-221	CFSB-221-SO-0-0.5	7-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-221	CFSB-221-SO-0.5-2	7-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-222	CFSB-222-SO-0-0.5	7-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-222	CFSB-222-SO-0.5-2	7-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-223	CFSB-223-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-223	CFSB-223-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-224	CFSB-224-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-224	CFSB-224-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-225	CFSB-225-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-225	CFSB-225-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-226	CFSB-226-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-226	CFSB-226-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-227	CFSB-227-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-227	CFSB-227-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-228	CFSB-228-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-228	CFSB-228-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-229	CFSB-229-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-229	CFSB-229-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-230	CFSB-230-SO-0-0.5	7-May-18	0 - 0.5	PCBs
CFSB-230	CFSB-230-SO-0.5-2	7-May-18	0.5 - 2	PCBs
CFSB-261	CFSB-261-SO-0-0.5	2-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-261	CFSB-261-SO-0.5-2	2-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-262	CFSB-262-SO-0-0.5	2-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-262	CFSB-262-SO-0.5-2	2-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-263	CFSB-263-SO-0-0.5	2-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-263	CFSB-263-SO-0.5-2	2-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-264	CFSB-264-SO-0-0.5	3-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-264	CFSB-264-SO-0.5-2	3-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-265	CFSB-265-SO-0-0.5	3-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-265	CFSB-265-SO-0.5-2	3-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-270	CFSB-270-SO-0-0.5	2-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-270	CFSB-270-SO-0.5-2	2-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-271	CFSB-271-SO-0-0.5	2-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-271	CFSB-271-SO-0.5-2	2-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-277	CFSB-277-SO-0-0.5	3-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-277	CFSB-277-SO-0.5-2	3-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-289	CFSB-289-SO-0-0.5	28-Jun-18	0 - 0.5	Metals, Hex Chrom
CFSB-289	CFSB-289-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-289	CFSB-289-SO-0.5-2	28-Jun-18	0.5 - 2	Metals, Hex Chrom
CFSB-289	CFSB-289-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-290	CFSB-290-SO-0-0.5	28-Jun-18	0 - 0.5	Metals, Hex Chrom
CFSB-290	CFSB-290-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-290	CFSB-290-SO-0.5-2	28-Jun-18	0.5 - 2	Metals, Hex Chrom
CFSB-290	CFSB-290-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-291	CFSB-291-SO-0-0.5	22-Jun-18	0 - 0.5	Metals, Hex Chrom
CFSB-291	CFSB-291-SO-0.5-2	22-Jun-18	0.5 - 2	Metals, Hex Chrom
CFSB-292	CFSB-292-SO-0-0.5	22-Jun-18	0 - 0.5	Metals
CFSB-292	CFSB-292-SO-0.5-2	22-Jun-18	0.5 - 2	Metals, Hex Chrom

Notes:

Table 4-2
Samples Used in the Baseline Ecological Risk Assessment - Central Landfills Area
Central Landfills Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses

[a]: Triplicate incremental field replicates were collected for these samples.

Gen Chem: general chemistry parameters

Hex Chrom: hexavalent chromium

PCBs: polychlorinated biphenyls

Pest: pesticides

Phys: physical characteristics

SVOCs: semivolatile organic compounds

VOCs: volatile organic compounds

Table 4-3
Samples Used in the Baseline Ecological Risk Assessment - Industrial Landfill Area
Industrial Landfill Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFLP-001	CFLP-001-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-001	CFLP-001-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-002	CFLP-002-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-002	CFLP-002-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-003	CFLP-003-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-003	CFLP-003-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-004	CFLP-004-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-004	CFLP-004-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-005	CFLP-005-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-005	CFLP-005-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs
CFLP-006	CFLP-006-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFLP-006	CFLP-006-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, Phys, SVOCs

Notes:
Gen Chem: general chemistry parameters
PCBs: polychlorinated biphenyls
Phys: physical characteristics
SVOCs: semivolatile organic compounds

Table 4-4
Samples Used in the Baseline Ecological Risk Assessment - Eastern Undeveloped Area
Eastern Undeveloped Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFSB-181	CFSB-181-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-181	CFSB-181-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-182	CFSB-182-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-182	CFSB-182-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-183	CFSB-183-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-183	CFSB-183-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-184	CFSB-184-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-184	CFSB-184-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-185	CFSB-185-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-185	CFSB-185-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-186	CFSB-186-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-186	CFSB-186-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-187	CFSB-187-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-187	CFSB-187-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-188	CFSB-188-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-188	CFSB-188-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-209	CFSB-209-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-209	CFSB-209-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-210	CFSB-210-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-210	CFSB-210-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-211	CFSB-211-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-211	CFSB-211-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-212	CFSB-212-SO-0-0.5	26-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-212	CFSB-212-SO-0.5-2	26-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-267	CFSB-267-SO-0-0.5	10-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-267	CFSB-267-SO-0.5-2	10-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-268	CFSB-268-SO-0-0.5	10-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-268	CFSB-268-SO-0.5-2	10-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-269	CFSB-269-SO-0-0.5	9-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-269	CFSB-269-SO-0.5-2	9-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFTP-17	CFTP-17-SO-0-0.5	25-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFTP-18	CFTP-18-SO-0-0.5	26-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFTP-19	CFTP-19-SO-0-0.5	25-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFTP-20	CFTP-20-SO-0-0.5	25-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFTP-21	CFTP-21-SO-0-0.5	25-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFTP-22	CFTP-22-SO-0-0.5	25-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFTP-23	CFTP-23-SO-0-0.5	26-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs

Notes:
Gen Chem: general chemistry parameters
PCBs: polychlorinated biphenyls
Pest: pesticides
SVOCs: semivolatile organic compounds
VOCs: volatile organic compounds

Table 4-5
Samples Used in the Baseline Ecological Risk Assessment - North-Central Undeveloped Area
North-Central Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFMW-003A	CFMW-003a-SO-0-0.5	31-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-003A	CFMW-003a-SO-0.5-2	31-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-011A	CFMW-011a-SO-0-0.5	25-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-011A	CFMW-011a-SO-0.5-2	25-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-066	CFMW-066-SO-0-0.5	30-Apr-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFMW-066	CFMW-066-SO-0.5-2	30-Apr-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFMW-067	CFMW-067-SO-0-0.5	1-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFMW-067	CFMW-067-SO-0.5-2	1-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-011	CFSB-011-SO-0-0.5	19-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-011	CFSB-011-SO-0.5-2.0	19-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-013	CFSB-013-SO-0-0.5	19-May-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-013	CFSB-013-SO-0.5-2.0	19-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-173	CFSB-173-SO-0-0.5	25-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-173	CFSB-173-SO-0.5-2	25-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-174	CFSB-174-0-0.5	25-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-174	CFSB-174-0.5-2	25-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-175	CFSB-175-SO-0-0.5	25-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-175	CFSB-175-SO-0.5-2	25-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-176	CFSB-176-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-176	CFSB-176-SO-0.5-2	16-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-191	CFSB-191-SO-0-0.5	22-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-191	CFSB-191-SO-0.5-2	22-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-192	CFSB-192-SO-0-0.5	22-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-192	CFSB-192-SO-0.5-2	22-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-193	CFSB-193-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-193	CFSB-193-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-194	CFSB-194-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-194	CFSB-194-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-195	CFSB-195-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-195	CFSB-195-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-197	CFSB-197-SO-0-0.5	21-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-197	CFSB-197-SO-0.5-2	21-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-198	CFSB-198-SO-0-0.5	21-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-198	CFSB-198-SO-0.5-2	21-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-200	CFSB-200-SO-0-0.5	28-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-200	CFSB-200-SO-0.5-2	28-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-241	CFSB-241-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-241	CFSB-241-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-250	CFSB-250-SO-0-0.5	1-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-250	CFSB-250-SO-0.5-2	1-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-252	CFSB-252-SO-0-0.5	1-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-252	CFSB-252-SO-0.5-2	1-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-253	CFSB-253-SO-0-0.5	1-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-253	CFSB-253-SO-0.5-2	1-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-254	CFSB-254-SO-0-0.5	30-Apr-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-254	CFSB-254-SO-0.5-2	30-Apr-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-257	CFSB-257-SO-0-0.5	30-Apr-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-257	CFSB-257-SO-0.5-2	30-Apr-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-258	CFSB-258-SO-0-0.5	30-Apr-18	0 - 0.5	Gen Chem, Metals, SVOCs

Table 4-5
Samples Used in the Baseline Ecological Risk Assessment - North-Central Undeveloped Area
North-Central Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSB-258	CFSB-258-SO-0.5-2	30-Apr-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-259	CFSB-259-SO-0-0.5	30-Apr-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-259	CFSB-259-SO-0.5-2	30-Apr-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-260	CFSB-260-SO-0-0.5	5-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-260	CFSB-260-SO-0.5-2	5-May-18	0.5 - 2	Gen Chem, Metals, SVOCs

Notes:

Gen Chem: general chemistry parameters

PCBs: polychlorinated biphenyls

Pest: pesticides

SVOCs: semivolatile organic compounds

VOCs: volatile organic compounds

Table 4-6
Samples Used in the Baseline Ecological Risk Assessment - Western Undeveloped Area
Western Undeveloped Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFMW-025A	CFMW-025a-SO-0-0.5	13-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-025A	CFMW-025a-SO-0.5-2	13-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-026	CFMW-026-SO-0-0.5	14-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-026	CFMW-026-SO-0.5-2	14-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-056A	CFMW-056a-SO-0-0.5	15-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-056A	CFMW-056a-SO-0.5-2	15-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-057A	CFMW-057a-SO-0-0.5	27-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-057A	CFMW-057a-SO-0.5-2	27-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-059A	CFMW-059a-SO-0-0.5	22-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-059A	CFMW-059a-SO-0.5-2	22-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-065	CFMW-065-SO-0-0.5	2-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFMW-065	CFMW-065-SO-0.5-2	2-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFMW-068	CFMW-068-SO-0-0.5	10-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFMW-068	CFMW-068-SO-0.5-2	10-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFMW-069	CFMW-069-SO-0-0.5	8-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFMW-069	CFMW-069-SO-0.5-2	8-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFMW-071	CFMW-071-SO-0-0.5	3-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFMW-071	CFMW-071-SO-0.5-2	3-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-120	CFSB-120-SO-0-0.5	18-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-120	CFSB-120-SO-0.5-2.0	18-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-121	CFSB-121-SO-0-0.5	18-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-121	CFSB-121-SO-0.5-2.0	18-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-122	CFSB-122-SO-0-0.5	19-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-122	CFSB-122-SO-0.5-2.0	19-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-123	CFSB-123-SO-0-0.5	19-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-123	CFSB-123-SO-0.5-2.0	19-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-124	CFSB-124-SO-0-0.5	19-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-124	CFSB-124-SO-0.5-2.0	19-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-125	CFSB-125-SO-0-0.5	18-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-125	CFSB-125-SO-0.5-2.0	18-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-126	CFSB-126-SO-0-0.5	18-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-126	CFSB-126-SO-0.5-2.0	18-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-127	CFSB-127-SO-0-0.5	18-May-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-127	CFSB-127-SO-0.5-2.0	18-May-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-132	CFSB-132-SO-0-0.5	3-Jun-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-132	CFSB-132-SO-0.5-2	3-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-133	CFSB-133-SO-0-0.5	3-Jun-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-133	CFSB-133-SO-0.5-2	3-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-168	CFSB-168-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-168	CFSB-168-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-168	CFSB-168-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-168	CFSB-168-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-169	CFSB-169-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-169	CFSB-169-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-170	CFSB-170-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-170	CFSB-170-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-171	CFSB-171-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-171	CFSB-171-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-172	CFSB-172-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-172	CFSB-172-SO-0-0.5	26-Sep-18	0 - 0.5	Dioxins
CFSB-172	CFSB-172-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs

Table 4-6
Samples Used in the Baseline Ecological Risk Assessment - Western Undeveloped Area
Western Undeveloped Area Terrestrial Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSB-172	CFSB-172-SO-0.5-2	26-Sep-18	0.5 - 2	Dioxins
CFSB-196	CFSB-196-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-196	CFSB-196-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-196	CFSB-196-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-196	CFSB-196-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-215	CFSB-215-SO-0-0.5	21-Jun-18	0 - 0.5	Dioxins, Gen Chem, Metals, SVOCs
CFSB-215	CFSB-215-SO-0.5-2	21-Jun-18	0.5 - 2	Dioxins, Gen Chem, Metals, SVOCs
CFSB-216	CFSB-216-SO-0-0.5	21-Jun-18	0 - 0.5	Dioxins, Gen Chem, Metals, SVOCs
CFSB-216	CFSB-216-SO-0.5-2	21-Jun-18	0.5 - 2	Dioxins, Gen Chem, Metals, SVOCs
CFSB-217	CFSB-217-SO-0-0.5	21-Jun-18	0 - 0.5	Dioxins, Gen Chem, Metals, SVOCs
CFSB-217	CFSB-217-SO-0.5-2	21-Jun-18	0.5 - 2	Dioxins, Gen Chem, Metals, SVOCs
CFSB-218	CFSB-218-SO-0-0.5	21-Jun-18	0 - 0.5	Dioxins, Gen Chem, Metals, SVOCs
CFSB-218	CFSB-218-SO-0.5-2	21-Jun-18	0.5 - 2	Dioxins, Gen Chem, Metals, SVOCs
CFSB-237	CFSB-237-SO-0-0.5	21-Jun-18	0 - 0.5	Dioxins, Gen Chem, Metals, SVOCs
CFSB-237	CFSB-237-SO-0.5-2	21-Jun-18	0.5 - 2	Dioxins, Gen Chem, Metals, SVOCs
CFSB-238	CFSB-238a-SO-0-0.5	25-Sep-18	0 - 0.5	VOCs
CFSB-238	CFSB-238-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-238	CFSB-238-SO-0-0.5	25-Sep-18	0 - 0.5	Dioxins
CFSB-238	CFSB-238a-SO-0.5-2	25-Sep-18	0.5 - 2	VOCs
CFSB-238	CFSB-238-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-238	CFSB-238-SO-0.5-2	25-Sep-18	0.5 - 2	Dioxins
CFSB-239	CFSB-239-SO-0-0.5	27-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-239	CFSB-239-SO-0-0.5	27-Sep-18	0 - 0.5	Dioxins
CFSB-239	CFSB-239-SO-0.5-2	27-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-239	CFSB-239-SO-0.5-2	27-Sep-18	0.5 - 2	Dioxins
CFSB-244	CFSB-244-SO-0-0.5	9-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-244	CFSB-244-SO-0.5-2	9-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-245	CFSB-245-SO-0-0.5	8-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-245	CFSB-245-SO-0.5-2	8-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-246	CFSB-246-SO-0-0.5	9-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-246	CFSB-246-SO-0.5-2	9-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-247	CFSB-247-SO-0-0.5	9-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-247	CFSB-247-SO-0.5-2	9-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-248	CFSB-248-SO-0-0.5	1-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-248	CFSB-248-SO-0.5-2	1-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-249	CFSB-249-SO-0-0.5	1-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-249	CFSB-249-SO-0.5-2	1-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-251	CFSB-251-SO-0-0.5	1-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-251	CFSB-251-SO-0.5-2	1-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-255	CFSB-255-SO-0-0.5	30-Apr-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-255	CFSB-255-SO-0.5-2	30-Apr-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-256	CFSB-256-SO-0-0.5	30-Apr-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-256	CFSB-256-SO-0.5-2	30-Apr-18	0.5 - 2	Gen Chem, Metals, SVOCs

Notes:
Gen Chem: general chemistry parameters
PCBs: polychlorinated biphenyls
Pest: pesticides
SVOCs: semivolatile organic compounds
VOCs: volatile organic compounds

Table 4-7
Samples Used in the Baseline Ecological Risk Assessment - Flathead River Riparian Area
Flathead River Riparian Area Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFMW-061	CFMW-061-SO-0-0.5	12-Jul-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFMW-061	CFMW-061-SO-0.5-2	12-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFMW-064	CFMW-064-SO-0-0.5	11-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-064	CFMW-064-SO-0.5-2	11-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-114	CFSB-114-SO-0-0.5	12-Jul-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-114	CFSB-114-SO-0.5-2	12-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-119	CFSB-119-SO-0-0.5	12-Jul-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-119	CFSB-119-SO-0.5-2	12-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-134	CFSB-134-SO-0-0.5	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-134	CFSB-134-SO-0.5-2	31-Oct-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-135	CFSB-135-SO-0-0.5	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-135	CFSB-135-SO-0.5-2	31-Oct-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-136	CFSB-136-SO-0-0.5	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-136	CFSB-136-SO-0.5-2	31-Oct-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-137	CFSB-137-SO-0-0.5	1-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-137	CFSB-137-SO-0.5-2	1-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-137	CFSB-137-SO-0.5-2	2-Nov-17	0.5 - 2	VOCs
CFSB-138	CFSB-138-SO-0-0.5	1-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-138	CFSB-138-SO-0.5-2	1-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-139	CFSB-139-SO-0-0.5	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-139	CFSB-139-SO-0.5-2	31-Oct-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-140	CFSB-140-SO-0-0.5	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-140	CFSB-140-SO-0.5-2	31-Oct-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-141	CFSB-141-SO-0-0.5	1-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-141	CFSB-141-SO-0.5-2	1-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-141	CFSB-141-SO-0.5-2	2-Nov-17	0.5 - 2	VOCs
CFSB-142	CFSB-142-SO-0-0.5	2-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-142	CFSB-142-SO-0.5-2	2-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-143	CFSB-143-SO-0-0.5	2-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-143	CFSB-143-SO-0.5-2	2-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-144	CFSB-144-SO-0-0.5	3-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-144	CFSB-144-SO-0.5-2	3-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-145	CFSB-145-SO-0-0.5	6-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-145	CFSB-145-SO-0.5-2	6-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-146	CFSB-146-SO-0-0.5	6-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-146	CFSB-146-SO-0.5-2	6-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-147	CFSB-147-SO-0-0.5	6-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-147	CFSB-147-SO-0.5-2	6-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
CFSB-148	CFSB-148-SO-0-0.5	6-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-148	CFSB-148-SO-0.5-2	6-Nov-17	0.5 - 2	Gen Chem, Metals, SVOCs, VOCs
Sediment Samples [a]				
CFSDP-029	CFSDP-029-SD	1-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-030	CFSDP-030-SD	3-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-031	CFSDP-031-SD	3-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-032	CFSDP-032-SD	3-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-033	CFSDP-033-SD	3-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-029	CFSDP-029-SD	18-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs, SVOCs-SIM
CFSDP-030	CFSDP-030-SD	18-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-031	CFSDP-031-SD	18-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs
CFSDP-032	CFSDP-032-SD	17-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs, SVOCs-SIM
CFSDP-033	CFSDP-033-SD	17-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs, SVOCs-SIM
Surface Water Samples [a]				
CFSWP-029	CFSWP-029-SW	1-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-029	CFSWP-029-SW	22-Jun-18	NA	Gen Chem, Metals (f&uf)

Table 4-7
Samples Used in the Baseline Ecological Risk Assessment - Flathead River Riparian Area
Flathead River Riparian Area Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSWP-029	CFSWP-029-SW	18-Oct-18	NA	Gen Chem, Metals (f&uf), SVOCs, SVOCs-SIM
CFSWP-030	CFSWP-030-SW	3-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-030	CFSWP-030-SW	22-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-030	CFSWP-030-SW	18-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-031	CFSWP-031-SW	3-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-031	CFSWP-031-SW	22-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-031	CFSWP-031-SW	18-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-032	CFSWP-032-SW	3-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-032	CFSWP-032-SW	22-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-032	CFSWP-032-SW	17-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-033	CFSWP-033-SW	3-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-033	CFSWP-033-SW	22-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-033	CFSWP-033-SW	17-Oct-18	NA	Gen Chem, Metals (f&uf)
Pore Water Samples [a]				
CFPWP-029	CFPWP-029-PW	18-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFPWP-030	CFPWP-030-PW	18-Oct-18	0.5 - 1.5	Gen Chem, Metals, Phys, SVOCs
CFPWP-031	CFPWP-031-PW	18-Oct-18	0.5 - 1.5	Gen Chem, Metals, Phys, SVOCs
CFPWP-032	CFPWP-032-PW	17-Oct-18	0.5 - 1.5	Gen Chem, Metals, Phys, SVOCs
CFPWP-033	CFPWP-033-PW	17-Oct-18	0.5 - 1.5	Gen Chem, Metals, Phys, SVOCs

Notes:

[a]: Samples collected from channel draining the Flathead River Riparian Area to the Backwater Seep Sampling Area. Although located in the Flathead River Riparian Area, these samples will collected primarily to evaluate cyanide and fluoride pathways from the shallow groundwater to the Backwater Seep area, and will be evaluated separately.

Gen Chem: general chemistry parameters

Metals-SEM: simultaneously extracted metals

Metals (f&uf): filtered and unfiltered metals

PCBs: polychlorinated biphenyls

Pest: pesticides

SVOCs: semivolatile organic compounds

SVOCs-SIM: semivolatile organic compounds, selected ion monitoring

VOC: volatile organic compounds

Table 4-8
Samples Used in the Baseline Ecological Risk Assessment - North Percolation Pond Area
North Percolation Pond Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFMW-027	CFMW-027-SO-0-0.5	30-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFMW-027	CFMW-027-SO-0.5-2	30-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-014	CFSB-014-SO-0-0.5	2-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-014	CFSB-014-SO-0.5-2	2-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-016	CFSB-016-SO-0-0.5	2-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-016	CFSB-016-SO-0.5-2	2-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-019	CFSB-019-SO-0-0.5	4-Jun-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-019	CFSB-019-SO-0.5-2	4-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-025	CFSB-025-SO-0-0.5	13-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-025	CFSB-025-SO-0.5-2	13-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-026	CFSB-026-SO-0-0.5	13-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-026	CFSB-026-SO-0.5-2	13-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-027	CFSB-027-SO-0-0.5	13-Jun-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-027	CFSB-027-SO-0.5-2	13-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-028	CFSB-028-SO-0-0.5	18-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-028	CFSB-028-SO-0.5-2	18-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-030	CFSB-030-SO-0-0.5	13-Jun-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-030	CFSB-030-SO-0.5-2	13-Jun-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-199	CFSB-199-SO-0-0.5	28-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFSB-199	CFSB-199-SO-0.5-2	28-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFSB-201	CFSB-201-SO-0-0.5	22-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFSB-201	CFSB-201-SO-0-0.5	29-Jun-18	0 - 0.5	SVOCs
CFSB-201	CFSB-201-SO-0.5-2	22-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs-SIM
CFSB-202	CFSB-202-SO-0-0.5	22-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFSB-202	CFSB-202-SO-0-0.5	29-Jun-18	0 - 0.5	SVOCs
CFSB-202	CFSB-202-SO-0.5-2	22-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFSB-203	CFSB-203-SO-0-0.5	28-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFSB-203	CFSB-203-SO-0.5-2	28-Jun-18	0.5 - 2	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFSB-204	CFSB-204-SO-0-0.5	22-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-204	CFSB-204-SO-0.5-2	22-Jun-18	0.5 - 2	Gen Chem, Metals
CFSB-214	CFSB-214-SO-0-0.5	22-Jun-18	0 - 0.5	Gen Chem, Metals, Hex Chrom, SVOCs, SVOCs-SIM
CFSB-214	CFSB-214-SO-0.5-2	22-Jun-18	0.5 - 2	Gen Chem, Metals, Hex Chrom, SVOCs, SVOCs-SIM
CFSB-272	CFSB-272-SO-0-0.5	4-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-272	CFSB-272-SO-0-0.5	28-Jun-18	0 - 0.5	SVOCs-SIM
CFSB-272	CFSB-272-SO-0.5-2	4-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-272	CFSB-272-SO-0.5-2	28-Jun-18	0.5 - 2	SVOCs-SIM
CFSB-273	CFSB-273-SO-0-0.5	4-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-273	CFSB-273-SO-0-0.5	22-Jun-18	0 - 0.5	Metals, Hex Chrom
CFSB-273	CFSB-273-SO-0.5-2	4-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-273	CFSB-273-SO-0.5-2	22-Jun-18	0.5 - 2	Metals, Hex Chrom
CFSB-279	CFSB-279-SO-0-0.5	8-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-279	CFSB-279-SO-0-0.5	22-Jun-18	0 - 0.5	SVOCs-SIM
CFSB-279	CFSB-279-SO-0.5-2	22-Jun-18	0.5 - 2	SVOCs-SIM
CFSB-279	CFSB-279-SO-0.5-2	8-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-280	CFSB-280-SO-0-0.5	8-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-280	CFSB-280-SO-0-0.5	22-Jun-18	0 - 0.5	SVOCs-SIM
CFSB-280	CFSB-280-SO-0.5-2	8-May-18	0.5 - 2	Gen Chem, Metals, SVOCs
CFSB-280	CFSB-280-SO-0.5-2	22-Jun-18	0.5 - 2	SVOCs-SIM
CFSB-281	CFSB-281-SO-0-0.5	4-May-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-281	CFSB-281-SO-0-0.5	22-Jun-18	0 - 0.5	Metals, Hex Chrom
CFSB-281	CFSB-281-SO-0.5-2	4-May-18	0.5 - 2	Gen Chem, Metals, SVOCs

Table 4-8
Samples Used in the Baseline Ecological Risk Assessment - North Percolation Pond Area
North Percolation Pond Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSB-281	CFSB-281-SO-0.5-2	22-Jun-18	0.5 - 2	Metals, Hex Chrom
Sediment Samples				
CFSDP-023	CFSDP-023-SD	7-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-024	CFSDP-024-SD	7-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
Surface Water Samples				
CFSWP-023	CFSWP-023-SW	3-Apr-17	NA	Gen Chem, Metals
CFSWP-024	CFSWP-024-SW	15-Jun-17	NA	Gen Chem, Metals (f&uf), Pest, PCBs, SVOCs, VOCs

Notes:

Gen Chem: general chemistry parameters
Hex Chrom: hexavalent chromium
Metals (f&uf): filtered and unfiltered metals
PCBs: polychlorinated biphenyls
Pest: pesticides
Phys: physical characteristics
SVOCs: semivolatile organic compounds
SVOCs-SIM: semivolatile organic compounds, selected ion monitoring
VOCs: volatile organic compounds

Table 4-9
Samples Used in the Baseline Ecological Risk Assessment - South Percolation Pond Area
South Percolation Pond Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFSB-101	CFSB-101-SO-0-0.5	21-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-101	CFSB-101-SO-0.5-2	21-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-102	CFSB-102-SO-0-0.5	13-Jul-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-102	CFSB-102-SO-0.5-2	13-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-104	CFSB-104-SO-0-0.5	13-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-104	CFSB-104-SO-0.5-2	13-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-109	CFSB-109-SO-0-0.5	13-Jul-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-109	CFSB-109-SO-0.5-2	13-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-110	CFSB-110-SO-0-0.5	14-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-110	CFSB-110-SO-0.5-2	14-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-113	CFSB-113-SO-0-0.5	31-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-113	CFSB-113-SO-0.5-2	31-Aug-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-115	CFSB-115-SO-0-0.5	31-Aug-16	0 - 0.5	Gen Chem, Metals, PCBs, SVOCs
CFSB-115	CFSB-115-SO-0.5-2	31-Aug-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-116	CFSB-116-SO-0-0.5	22-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-116	CFSB-116-SO-0.5-2	22-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-118	CFSB-118-SO-0-0.5	21-Jul-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSB-118	CFSB-118-SO-0.5-2	21-Jul-16	0.5 - 2	Gen Chem, Metals, PCBs, SVOCs, VOCs
CFSB-151	CFSB-151-SO-0-0.5	7-Nov-17	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSB-151	CFSB-151-SO-0.5-2	7-Nov-17	0.5 - 2	Gen Chem, Metals, Phys, SVOCs, VOCs
CFSB-152	CFSB-152-SO-0-0.5	7-Nov-17	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSB-152	CFSB-152-SO-0.5-2	7-Nov-17	0.5 - 2	Gen Chem, Metals, Phys, SVOCs, VOCs
CFSB-153	CFSB-153-SO-0-0.5	6-Nov-17	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSB-153	CFSB-153-SO-0.5-2	6-Nov-17	0.5 - 2	Gen Chem, Metals, Phys, SVOCs, VOCs
Sediment Samples				
CFSB-149	CFSB-149-SD-0-0.5	7-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSB-150	CFSB-150-SD-0-0.5	7-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-018	CFSDP-018-SD	7-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-018	CFSDP-018-SD	7-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-018	CFSDP-018-SD	17-Oct-18	0 - 0.5	Gen Chem, Metals, Metals SEM, Phys, SVOCs
CFSDP-019	CFSDP-019-SD	7-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-019	CFSDP-019-SD	7-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-019	CFSDP-019-SD	16-Oct-18	0 - 0.5	Gen Chem, Metals, Metals SEM, Phys, SVOCs
CFSDP-020	CFSDP-020-SD	7-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-020	CFSDP-020-SD	7-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-020	CFSDP-020-SD	11-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-058	CFSDP-058-SD	11-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-059	CFSDP-059-SD	11-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-060	CFSDP-060-SD	16-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
Surface Water Samples				
CFSWP-018	CFSWP-018-SW	6-Jun-16	NA	Gen Chem, Metals, Pest, PCBs, SVOCs, VOCs
CFSWP-018	CFSWP-018-SW	1-Dec-16	NA	Gen Chem, Metals
CFSWP-018	CFSWP-018-SW	3-Apr-17	NA	Gen Chem, Metals
CFSWP-018	CFSWP-018-SW	15-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-018	CFSWP-018-SW	21-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-018	CFSWP-018-SW	17-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-019	CFSWP-019-SW	6-Jun-16	NA	Gen Chem, Metals, Pest, PCBs, SVOCs, VOCs
CFSWP-019	CFSWP-019-SW	1-Dec-16	NA	Gen Chem, Metals
CFSWP-019	CFSWP-019-SW	3-Apr-17	NA	Gen Chem, Metals

Table 4-9
Samples Used in the Baseline Ecological Risk Assessment - South Percolation Pond Area
South Percolation Pond Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSWP-019	CFSWP-019-SW	15-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-019	CFSWP-019-SW	7-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-019	CFSWP-019-SW	21-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-019	CFSWP-019-SW	16-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-020	CFSWP-020-SW	6-Jun-16	NA	Gen Chem, Metals, Pest, PCBs, SVOCs, VOCs
CFSWP-020	CFSWP-020-SW	1-Dec-16	NA	Gen Chem, Metals
CFSWP-020	CFSWP-020-SW	16-Mar-17	NA	Gen Chem, Metals
CFSWP-020	CFSWP-020-SW	15-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-020	CFSWP-020-SW	7-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-020	CFSWP-020-SW	21-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-020	CFSWP-020-SW	11-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-058	CFSWP-058-SW	21-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-058	CFSWP-058-SW	11-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-059	CFSWP-059-SW	22-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-059	CFSWP-059-SW	11-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-060	CFSWP-060-SW	22-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-060	CFSWP-060-SW	16-Oct-18	NA	Gen Chem, Metals (f&uf)
Pore Water Samples				
CFSWP-018	CFSWP-018-SW	17-Oct-18	NA	Gen Chem, Metals, SVOCs
CFSWP-019	CFSWP-019-SW	16-Oct-18	NA	Gen Chem, Metals, SVOCs
CFSWP-020	CFSWP-020-SW	11-Oct-18	NA	Gen Chem, Metals, SVOCs
CFSWP-058	CFSWP-058-SW	11-Oct-18	NA	Gen Chem, Metals, SVOCs
CFSWP-059	CFSWP-059-SW	11-Oct-18	NA	Gen Chem, Metals, SVOCs
CFSWP-060	CFSWP-060-SW	16-Oct-18	NA	Gen Chem, Metals, SVOCs

Notes:
Gen Chem: general chemistry parameters
Metals (f&uf): filtered and unfiltered metals
Metals - SEM: simultaneously extracted metals
PCBs: polychlorinated biphenyls
Pest: pesticides
Phys: physical characteristics
SVOCs: semivolatile organic compounds

Table 4-10
Samples Used in the Baseline Ecological Risk Assessment - Cedar Creek Reservoir Overflow Ditch
Cedar Creek Reservoir Overflow Ditch Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Soil Samples				
CFSB-282	CFSB-283-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-283	CFSB-283-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSB-284	CFSB-283-SO-0-0.5	16-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
Sediment Samples				
CFSDP-009	CFSDP-009-SO	6-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-010	CFSDP-010-SO	6-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-011	CFSDP-011-SO	6-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-012	CFSDP-012-SO	6-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-013	CFSDP-013-SO	6-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
Surface Water Samples				
CFSWP-009	CFSWP-009-SW	7-Jun-16	NA	Gen Chem, Metals
CFSWP-009	CFSWP-009-SW	3-Apr-17	NA	Gen Chem, Metals
CFSWP-009	CFSWP-009-SW	12-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-009	CFSWP-009-SW	14-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-010	CFSWP-010-SW	7-Jun-16	NA	Gen Chem, Metals
CFSWP-010	CFSWP-010-SW	15-Mar-17	NA	Gen Chem, Metals
CFSWP-010	CFSWP-010-SW	12-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-010	CFSWP-010-SW	14-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-011	CFSWP-011-SW	7-Jun-16	NA	Gen Chem, Metals
CFSWP-011	CFSWP-011-SW	3-Apr-17	NA	Gen Chem, Metals
CFSWP-011	CFSWP-011-SW	12-Jun-17	NA	Gen Chem, Metals
CFSWP-011	CFSWP-011-SW	14-Jun-18	NA	Gen Chem, Metals
CFSWP-012	CFSWP-012-SW	7-Jun-16	NA	Gen Chem, Metals
CFSWP-012	CFSWP-012-SW	3-Apr-17	NA	Gen Chem, Metals
CFSWP-012	CFSWP-012-SW	12-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-012	CFSWP-012-SW	14-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-013	CFSWP-013-SW	7-Jun-16	NA	Gen Chem, Metals
CFSWP-013	CFSWP-013-SW	30-Nov-16	NA	Gen Chem, Metals
CFSWP-013	CFSWP-013-SW	15-Mar-17	NA	Gen Chem, Metals
CFSWP-013	CFSWP-013-SW	12-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-013	CFSWP-013-SW	14-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-039	CFSWP-039-SW	15-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-039	CFSWP-039-SW	11-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-040	CFSWP-040-SW	15-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-041	CFSWP-041-SW	14-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-042	CFSWP-042-SW	14-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-043	CFSWP-043-SW	14-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-043	CFSWP-043-SW	18-Jun-18	NA	Gen Chem

Notes:
Gen Chem: general chemistry parameters
Metals (f&uf): filtered and unfiltered metals
PCBs: polychlorinated biphenyls
Pest: pesticides
Phys: physical characteristics
SVOCs: semivolatile organic compounds

Table 4-11
Samples Used in the Baseline Ecological Risk Assessment - Northern Surface Water Feature
Northern Surface Water Feature Transitional Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Sediment Samples				
CFSDP-021	CFSDP-021-SD	19-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-021	CFSDP-021-SO	6-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-022	CFSDP-022-SD	20-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-022	CFSDP-022-SO	6-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-046	CFSDP-046-SD	19-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSDP-047	CFSDP-047-SD	19-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSDP-048	CFSDP-048-SD	20-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-049	CFSDP-049-SD	20-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-050	CFSDP-050-SD	21-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSDP-051	CFSDP-051-SD	21-Jun-18	0 - 0.5	Gen Chem, Metals, SVOCs
CFSDP-052	CFSDP-052-SD	18-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-053	CFSDP-053-SD	18-Jun-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
Surface Water				
CFSWP-021	CFSWP-021-SW	6-Jun-16	NA	Gen Chem, Metals
CFSWP-021	CFSWP-021-SW	30-Nov-16	NA	Gen Chem, Metals
CFSWP-021	CFSWP-021-SW	15-Mar-17	NA	Gen Chem, Metals
CFSWP-021	CFSWP-021-SW	15-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-021	CFSWP-021-SW	19-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-022	CFSWP-022-SW	6-Jun-16	NA	Gen Chem, Metals
CFSWP-022	CFSWP-022-SW	3-Apr-17	NA	Gen Chem, Metals
CFSWP-022	CFSWP-022-SW	20-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-046	CFSWP-046-SW	19-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-047	CFSWP-047-SW	19-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-048	CFSWP-048-SW	20-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-049	CFSWP-049-SW	20-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-050	CFSWP-050-SW	21-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-051	CFSWP-051-SW	21-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-052	CFSWP-052-SW	18-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-053	CFSWP-053-SW	18-Jun-18	NA	Gen Chem, Metals (f&uf)
Pore Water				
CFPWP-021	CFPWP-021-PW	19-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-022	CFPWP-022-PW	20-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-046	CFPWP-046-PW	19-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-047	CFPWP-047-PW	19-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-048	CFPWP-048-PW	20-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-049	CFPWP-049-PW	20-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-050	CFPWP-050-PW	21-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-051	CFPWP-051-PW	21-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-052	CFPWP-052-PW	18-Jun-18	0.5 - 1.5	Gen Chem, Metals
CFPWP-053	CFPWP-053-PW	18-Jun-18	0.5 - 1.5	Gen Chem, Metals

Notes:
Gen Chem: general chemistry parameters
Metals (f&uf): filtered and unfiltered metals
PCBs: polychlorinated biphenyls
Pest: pesticides
Phys: physical characteristics
SVOCs: semivolatile organic compounds

Table 4-12
Samples Used in the Baseline Ecological Risk Assessment - Flathead River Area
Flathead River Aquatic Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Sediment Samples				
CFSDP-001	CFSDP-001-SO	8-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-001	CFSDP-001-SD	5-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-002	CFSDP-002-SO	8-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSDP-002	CFSDP-002-SO	16-Sep-16	0 - 0.5	Phys
CFSDP-002	CFSDP-002-SD	5-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-003	CFSDP-003-SD	9-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-003	CFSDP-003-SD	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-003	CFSDP-003-SD	4-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-004	CFSDP-004-SD	9-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-004	CFSDP-004-SD	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-004	CFSDP-004-SD	4-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-005	CFSDP-005-SD	9-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-005	CFSDP-005-SD	1-Nov-17	0 - 0.5	Gen Chem, Metals, SVOCs
CFSDP-005	CFSDP-005-SD	2-Nov-17	0 - 0.5	VOCs
CFSDP-005	CFSDP-005-SD	18-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs, SVOCs-SIM
CFSDP-006	CFSDP-006-SD	9-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, PCBs, SVOCs
CFSDP-006	CFSDP-006-SO	9-Sep-16	0 - 0.5	Phys
CFSDP-006	CFSDP-006-SD	4-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-007	CFSDP-007-SO	8-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-007	CFSDP-007-SD	3-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-008	CFSDP-008-SO	8-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-008	CFSDP-008-SD	3-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-017	CFSDP-017-SO	8-Sep-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-017	CFSDP-017-SD	3-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-026	CFSDP-026-SD	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-026	CFSDP-026-SD	5-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs, SVOCs-SIM
CFSDP-027	CFSDP-027-SD	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-027	CFSDP-027-SD	5-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs, SVOCs-SIM
CFSDP-028	CFSDP-028-SD	31-Oct-17	0 - 0.5	Gen Chem, Metals, SVOCs, VOCs
CFSDP-028	CFSDP-028-SD	4-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, SVOCs, SVOCs-SIM
CFSDP-034	CFSDP-034-SD	5-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-035	CFSDP-035-SD	5-Oct-18	0 - 0.5	Gen Chem, Metals, Metals-SEM, Phys, SVOCs, SVOCs-SIM
CFSDP-036	CFSDP-036-SD	4-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-037	CFSDP-037-SD	3-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-038	CFSDP-038-SD	3-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
Surface Water Samples				
CFSWP-001	CFSWP-001-SW	16-Sep-16	NA	Gen Chem, Metals
CFSWP-001	CFSWP-001-SW	2-Dec-16	NA	Gen Chem, Metals
CFSWP-001	CFSWP-001-SW	4-Apr-17	NA	Gen Chem, Metals
CFSWP-001	CFSWP-001-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-001	CFSWP-001-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-001	CFSWP-001-SW	5-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-002	CFSWP-002-SW	16-Sep-16	NA	Gen Chem, Metals
CFSWP-002	CFSWP-002-SW	2-Dec-16	NA	Gen Chem, Metals
CFSWP-002	CFSWP-002-SW	4-Apr-17	NA	Gen Chem, Metals
CFSWP-002	CFSWP-002-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-002	CFSWP-002-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-002	CFSWP-002-SW	5-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-003	CFSWP-003-SW	9-Sep-16	NA	Gen Chem, Metals
CFSWP-003	CFSWP-003-SW	1-Dec-16	NA	Gen Chem, Metals
CFSWP-003	CFSWP-003-SW	16-Mar-17	NA	Gen Chem, Metals
CFSWP-003	CFSWP-003-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-003	CFSWP-003-SW	31-Oct-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-003	CFSWP-003-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)

Table 4-12
Samples Used in the Baseline Ecological Risk Assessment - Flathead River Area
Flathead River Aquatic Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSWP-003	CFSWP-003-SW	7-Jun-18	NA	Gen Chem
CFSWP-003	CFSWP-003-SW	4-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-004	CFSWP-004-SW	9-Sep-16	NA	Gen Chem, Metals
CFSWP-004	CFSWP-004-SW	1-Dec-16	NA	Gen Chem, Metals
CFSWP-004	CFSWP-004-SW	16-Mar-17	NA	Gen Chem, Metals
CFSWP-004	CFSWP-004-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-004	CFSWP-004-SW	31-Oct-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-004	CFSWP-004-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-004	CFSWP-004-SW	4-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-005	CFSWP-005-SW	9-Sep-16	NA	Gen Chem, Metals
CFSWP-005	CFSWP-005-SW	1-Dec-16	NA	Gen Chem, Metals
CFSWP-005	CFSWP-005-SW	16-Mar-17	NA	Gen Chem, Metals
CFSWP-005	CFSWP-005-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-005	CFSWP-005-SW	1-Nov-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-005	CFSWP-005-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-005	CFSWP-005-SW	18-Oct-18	NA	Gen Chem, Metals (f&uf), SVOCs, SVOCs-SIM, VOCs
CFSWP-006	CFSWP-006-SW	9-Sep-16	NA	Gen Chem, Metals
CFSWP-006	CFSWP-006-SW	1-Dec-16	NA	Gen Chem, Metals
CFSWP-006	CFSWP-006-SW	16-Mar-17	NA	Gen Chem, Metals
CFSWP-006	CFSWP-006-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-006	CFSWP-006-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-006	CFSWP-006-SW	4-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-007	CFSWP-007-SW	16-Sep-16	NA	Gen Chem, Metals
CFSWP-007	CFSWP-007-SW	2-Dec-16	NA	Gen Chem, Metals
CFSWP-007	CFSWP-007-SW	16-Mar-17	NA	Gen Chem, Metals
CFSWP-007	CFSWP-007-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-007	CFSWP-007-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-007	CFSWP-007-SW	3-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-008	CFSWP-008-SW	16-Sep-16	NA	Gen Chem, Metals
CFSWP-008	CFSWP-008-SW	2-Dec-16	NA	Gen Chem, Metals
CFSWP-008	CFSWP-008-SW	4-Apr-17	NA	Gen Chem, Metals
CFSWP-008	CFSWP-008-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-008	CFSWP-008-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-008	CFSWP-008-SW	3-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-017	CFSWP-017-SW	16-Sep-16	NA	Gen Chem, Metals
CFSWP-017	CFSWP-017-SW	2-Dec-16	NA	Gen Chem, Metals
CFSWP-017	CFSWP-017-SW	4-Apr-17	NA	Gen Chem, Metals
CFSWP-017	CFSWP-017-SW	14-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-017	CFSWP-017-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-017	CFSWP-017-SW	3-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-026	CFSWP-026-SW	31-Oct-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-026	CFSWP-026-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-026	CFSWP-026-SW	5-Oct-18	NA	Gen Chem, Metals (f&uf), SVOCs, SVOCs-SIM
CFSWP-027	CFSWP-027-SW	31-Oct-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-027	CFSWP-027-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-027	CFSWP-027-SW	5-Oct-18	NA	Gen Chem, Metals (f&uf), SVOCs, SVOCs-SIM
CFSWP-028	CFSWP-028-SW	31-Oct-17	NA	Gen Chem, Metals (f&uf), SVOCs, VOCs
CFSWP-028	CFSWP-028-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-028	CFSWP-028-SW	4-Oct-18	NA	Gen Chem, Metals (f&uf), SVOCs, SVOCs-SIM
CFSWP-034	CFSWP-034-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-034	CFSWP-034-SW	5-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-035	CFSWP-035-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-035	CFSWP-035-SW	5-Oct-18	NA	Gen Chem, Metals (f&uf), SVOCs, SVOCs-SIM
CFSWP-036	CFSWP-036-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-036	CFSWP-036-SW	4-Oct-18	NA	Gen Chem, Metals (f&uf)

Table 4-12
Samples Used in the Baseline Ecological Risk Assessment - Flathead River Area
Flathead River Aquatic Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
CFSWP-037	CFSWP-037-SW	6-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-037	CFSWP-037-SW	3-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-038	CFSWP-038-SW	7-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-038	CFSWP-038-SW	3-Oct-18	NA	Gen Chem, Metals (f&uf)
Pore Water Samples				
CFPWP-001	CFPWP-001-PW	5-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-002	CFPWP-002-PW	5-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-003	CFPWP-003-PW	4-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-004	CFPWP-004-PW	4-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-005	CFPWP-005-PW	18-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFPWP-006	CFPWP-006-PW	4-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-007	CFPWP-007-PW	3-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-008	CFPWP-008-PW	3-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-017	CFPWP-017-PW	3-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-026	CFPWP-026-PW	5-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFPWP-027	CFPWP-027-PW	5-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFPWP-028	CFPWP-028-PW	4-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFPWP-034	CFPWP-034-PW	5-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-035	CFPWP-035-PW	5-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs, SVOCs-SIM
CFPWP-036	CFPWP-036-PW	4-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-037	CFPWP-037-PW	3-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-038	CFPWP-038-PW	3-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs

Notes:
Gen Chem: general chemistry parameters
Metals-SEM: simultaneously extracted metals
Metals (f&uf), filtered and unfiltered metals
PCBs: polychlorinated biphenyls
Pest: pesticides
Phys: physical characteristics
SVOCs: semivolatile organic compounds
SVOCs-SIM: semivolatile organic compounds, selected ion monitoring
VOCs: volatile organic compounds

Table 4-13
Samples Used in the Baseline Ecological Risk Assessment - Cedar Creek
Cedar Creek Aquatic Exposure Area
Columbia Falls Aluminum Company
Columbia Falls, Montana

Location	Sample Number	Sample Date	Depth (ft)	Analyses
Sediment Samples				
CFSDP-014	CFSDP-014-SD	29-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-015	CFSDP-015-SD	29-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-016	CFSDP-016-SD	29-Aug-16	0 - 0.5	Gen Chem, Metals, Pest, Phys, PCBs, SVOCs
CFSDP-014	CFSDP-014-SD	10-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-015	CFSDP-015-SD	9-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-016	CFSDP-016-SD	9-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-025	CFSDP-025-SD	10-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-044	CFSDP-044-SD	10-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
CFSDP-045	CFSDP-045-SD	9-Oct-18	0 - 0.5	Gen Chem, Metals, Phys, SVOCs
Surface Water Samples				
CFSWP-014	CFSWP-014-SW	29-Aug-16	NA	Gen Chem, Metals
CFSWP-014	CFSWP-014-SW	30-Nov-16	NA	Gen Chem, Metals
CFSWP-014	CFSWP-014-SW	13-Mar-17	NA	Gen Chem, Metals
CFSWP-014	CFSWP-014-SW	13-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-014	CFSWP-014-SW	11-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-014	CFSWP-014-SW	10-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-014	CFSWP-014-SW	16-Oct-18	NA	Gen Chem
CFSWP-015	CFSWP-015-SW	29-Aug-16	NA	Gen Chem, Metals
CFSWP-015	CFSWP-015-SW	30-Nov-16	NA	Gen Chem, Metals
CFSWP-015	CFSWP-015-SW	20-Dec-16	NA	Gen Chem, Metals
CFSWP-015	CFSWP-015-SW	13-Mar-17	NA	Gen Chem, Metals
CFSWP-015	CFSWP-015-SW	13-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-015	CFSWP-015-SW	11-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-015	CFSWP-015-SW	9-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-015	CFSWP-015-SW	16-Oct-18	NA	Gen Chem
CFSWP-016	CFSWP-016-SW	29-Aug-16	NA	Gen Chem, Metals
CFSWP-016	CFSWP-016-SW	30-Nov-16	NA	Gen Chem, Metals
CFSWP-016	CFSWP-016-SW	13-Mar-17	NA	Gen Chem, Metals
CFSWP-016	CFSWP-016-SW	12-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-016	CFSWP-016-SW	12-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-016	CFSWP-016-SW	9-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-025	CFSWP-025-SW	20-Dec-16	NA	Gen Chem, Metals
CFSWP-025	CFSWP-025-SW	13-Mar-17	NA	Gen Chem, Metals
CFSWP-025	CFSWP-025-SW	13-Jun-17	NA	Gen Chem, Metals (f&uf)
CFSWP-025	CFSWP-025-SW	12-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-025	CFSWP-025-SW	10-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-044	CFSWP-044-SW	11-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-044	CFSWP-044-SW	10-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-044	CFSWP-044-SW	16-Oct-18	NA	Gen Chem
CFSWP-045	CFSWP-045-SW	11-Jun-18	NA	Gen Chem, Metals (f&uf)
CFSWP-045	CFSWP-045-SW	9-Oct-18	NA	Gen Chem, Metals (f&uf)
CFSWP-045	CFSWP-045-SW	16-Oct-18	NA	Gen Chem
Pore Water Samples				
CFPWP-014	CFPWP-014-PW	10-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-015	CFPWP-015-PW	9-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-016	CFPWP-016-PW	9-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-025	CFPWP-025-PW	10-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-044	CFPWP-044-PW	10-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs
CFPWP-045	CFPWP-045-PW	9-Oct-18	0.5 - 1.5	Gen Chem, Metals, SVOCs

Notes:
Gen Chem: general chemistry parameters
Metals (f&uf): filtered and unfiltered metals
PCBs: polychlorinated biphenyls
Pest: pesticides
Phys: physical characteristics
SVOCs: semivolatile organic compounds

Table 4-14
Summary of Preliminary Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	Cedar Creek (Sediment)	Flathead River Riparian (Sediment)	Flathead River (Sediment)
Habitat		Terrestrial							ISS	Transitional								Aquatic		
	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5	0-0.5
TAL Metals																				
Aluminum	7429-90-5	●	●	●	●	●	●	●	●	●		●		●	●	●	●			
Antimony	7440-36-0	●	●	●			●		●			●				●	●			
Arsenic	7440-38-2	●	●	●	●	●	●	●	●	●				●	●	●	●			
Barium	7440-39-3	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Beryllium	7440-41-7		●	●			●		●		●		●	●	●	●	●	●	●	●
Cadmium	7440-43-9	●	●	●	●	●	●		●			●	●			●	●			
Chromium, Total	7440-47-3	●	●	●					●			●				●	●			
Chromium, Hexavalent	18540-29-9	●	●	●	●	●	●		●	●	●	●	●	NA	NA	●	●	NA	NA	NA
Chromium, Trivalent	16065-83-1	●	●	●					●		●	●	●	NA	NA	●	●	NA	NA	NA
Cobalt	7440-48-4	●	●	●	●	●	●	●	●	●		●		●		●				
Copper	7440-50-8	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●			
Iron	7439-89-6	●	●	●	●	●	●	●	●	●		●		●	●	●				
Lead	7439-92-1	●	●	●	●	●	●	●	●	●		●	●	●		●	●			
Manganese	7439-96-5	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●		
Mercury	7439-97-6	●			●							●	●			●				
Nickel	7440-02-0	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●			
Selenium	7782-49-2	●	●	●	●	●	●	●	●	●		●		●	●	●	●			
Silver	7440-22-4											●	●				●			
Thallium	7440-28-0	●	●	●	●	●	●		●			●	●			●	●		●	
Vanadium	7440-62-2	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Zinc	7440-66-6	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●			
Other Inorganic Parameters																				
Cyanide (Total)	57-12-5	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cyanide (Free)	STL00131	NA	NA	NA	NA	NA	NA		NA	NA	NA		●	NA	NA	NA	NA	NA		
Fluoride	16984-48-8	●	●	●					●							●				
Essential Nutrients (mg/kg)																				
Calcium	7440-70-2	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Magnesium	7439-95-4	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Potassium	7440-09-7	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Sodium	7440-23-5	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Dioxins and Furans																				
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	35822-46-9	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table 4-14
Summary of Preliminary Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	Habitat	Terrestrial							ISS	Transitional								Aquatic		
	Exposure Area	Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	Cedar Creek (Sediment)	Flathead River Riparian (Sediment)	Flathead River (Sediment)
Constituent	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5	0-0.5
	CAS Number																			
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	●		NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,7,8-Hexachlorodibenzo-P-Dioxin	39227-28-6	●		NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,6,7,8-Hexachlorodibenzo-P-Dioxin	57653-85-7	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	●		NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8,9-Hexachlorodibenzo-P-Dioxin	19408-74-3	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	●		NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8-Pentachlorodibenzo-P-Dioxin	40321-76-4	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	●	●	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,7,8-Tetrachlorodibenzo-P-Dioxin	1746-01-6	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzofuran	39001-02-0	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzo-P-Dioxin	3268-87-9	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$TEC_{2,3,7,8\text{-TCDD-Bird-1/2MDL}}$	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$TEC_{2,3,7,8\text{-TCDD-Bird-MDL}}$	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$TEC_{2,3,7,8\text{-TCDD-Bird-Zero}}$	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$TEC_{2,3,7,8\text{-TCDD-Mammal-1/2MDL}}$	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$TEC_{2,3,7,8\text{-TCDD-Mammal-MDL}}$	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
$TEC_{2,3,7,8\text{-TCDD-Mammal-Zero}}$	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)																				
PCB-1248 (Aroclor 1248)	12672-29-6			NA					●										NA	
PCB-1254 (Aroclor 1254)	11097-69-1	●	●	NA					●										NA	
Polychlorinated Biphenyl (PCBs)	1336-36-3	●	●	NA					●										NA	
Polycyclic Aromatic Hydrocarbons (PAHs)																				
2-Methylnaphthalene	91-57-6		●						●							●	●			
Acenaphthene	83-32-9	●	●	●					●		●		●			●	●	●		●
Acenaphthylene	208-96-8																●	●		
Anthracene	120-12-7	●	●						●		●		●		●	●	●	●		●
Fluoranthene	206-44-0	●	●	●					●		●		●		●	●	●	●	●	●
Fluorene	86-73-7	●	●						●		●		●			●	●	●		●
Naphthalene	91-20-3	●	●	●				●	●		●					●	●			●
Phenanthrene	85-01-8	●	●	●					●		●		●		●	●	●	●	●	●

Table 4-14
Summary of Preliminary Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	Habitat	Terrestrial							ISS	Transitional								Aquatic		
	Exposure Area	Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	Cedar Creek (Sediment)	Flathead River Riparian (Sediment)	Flathead River (Sediment)
Constituent	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5	0-0.5
	CAS Number																			
Total LMW PAHs - 1/2MDL	---	●	●	●					●		●		●		●	●	●	●	●	●
Total LMW PAHs - MDL	---	●	●	●					●		●		●		●	●	●	●	●	●
Total LMW PAHs - Zero	---	●	●	●					●		●		●		●	●	●	●	●	●
Benzo(A)Pyrene	50-32-8	●	●	●	●				●		●	●	●		●	●	●	●	●	●
Benzo(A)Anthracene	56-55-3	●	●	●	●				●	●	●	●	●		●	●	●	●	●	●
Benzo(B)Fluoranthene	205-99-2	●	●	●					●							●	●			
Benzo(G,H,I)Perylene	191-24-2	●	●	●					●		●		●		●	●	●	●	●	●
Benzo(K)Fluoranthene	207-08-9								●		●		●			●	●			●
Chrysene	218-01-9	●	●	●					●		●		●		●	●	●	●	●	●
Dibenz(A,H)Anthracene	53-70-3	●	●						●		●		●		●	●	●		●	●
Indeno(1,2,3-C,D)Pyrene	193-39-5	●	●						●		●		●		●	●	●	●	●	●
Pyrene	129-00-0	●	●	●					●		●		●		●	●	●	●	●	●
Total HMW PAHs - 1/2MDL	---	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
Total HMW PAHs - MDL	---	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
Total HMW PAHs - Zero	---	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
Total PAHs - 1/2MDL	---	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
Total PAHs - MDL	---	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
Total PAHs - Zero	---	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																				
2,4-Dimethylphenol	105-67-9								●											
3- And 4- Methylphenol (Total)	106445	●	●	NA	●				●			●	●							●
4-Chloroaniline	106-47-8											●	●							
Acetophenone	98-86-2										●				●		●		●	
Benzaldehyde	100-52-7	●	●		●	●	●	●	●	●	●	●	●	●	●			●	●	●
Benzyl Butyl Phthalate	85-68-7	●	●						●							●				
Bis(2-Ethylhexyl) Phthalate	117-81-7	●	●		●	●	●		●	●		●	●			●				●
Caprolactam	105-60-2		●					●												
Carbazole	86-74-8										●		●		●	●	●	●	●	●
Dibenzofuran	132-64-9		●						●							●	●			
Di-N-Butyl Phthalate	84-74-2	●	●		●		●	●	●	●		●								
Hexachlorobenzene	118-74-1	●																		
Pentachlorophenol	87-86-5	●																		
Phenol	108-95-2		●												●				●	

Table 4-14
Summary of Preliminary Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Habitat		Terrestrial							ISS	Transitional								Aquatic		
Exposure Area		Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	Cedar Creek (Sediment)	Flathead River Riparian (Sediment)	Flathead River (Sediment)
Constituent	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5	0-0.5
	CAS Number																			
TCL Volatile Organic Compounds (TCL VOCs)																				
Acetone	67-64-1			NA	NA				NA	NA	NA		●	NA	NA		NA	NA	●	●
Carbon Disulfide	75-15-0			NA	NA				NA	NA	NA		●	NA	NA		NA	NA	●	●
Cyclohexane	110-82-7	●	●	NA	NA		●	●	NA	NA	NA	●	●	NA	NA	●	NA	NA	●	●
Isopropylbenzene (Cumene)	98-82-8	●	●	NA	NA				NA	NA	NA			NA	NA	●	NA	NA		
Methyl Acetate	79-20-9	●	●	NA	NA	●	●	●	NA	NA	NA	●		NA	NA	●	NA	NA		●
Methyl Ethyl Ketone (2-Butanone)	78-93-3			NA	NA				NA	NA	NA		●	NA	NA		NA	NA		
Methylcyclohexane	108-87-2	●	●	NA	NA		●	●	NA	NA	NA	●	●	NA	NA	●	NA	NA	●	●
M,P-Xylene	179601-23-1	●	●	NA	NA		●	●	NA	NA	NA	●		NA	NA	●	NA	NA		
O-Xylene (1,2-Dimethylbenzene)	95-47-6	●	●	NA	NA			●	NA	NA	NA	●		NA	NA	●	NA	NA		

Notes:
● - COPEC
Blank - Constituent measured but not COPEC
ft - feet
HMW - High molecular weight
ISS - Incremental Soil Sample
LMW - Low molecular weight
MDL - Method Detection Limit
mg/kg - milligrams per kilogram
NA - Not Applicable, constituent was not measured
PAH - Polycyclic Aromatic Hydrocarbons
PCB - Polychlorinated Biphenyls
SVOC - Semi-volatile organic compound
TAL - Target Analyte List
TCL - Target Compound List
VOC - Volatile organic compound

Table 4-15
Summary of Preliminary Surface Water COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area			Cedar Creek	Cedar Creek Reservoir Overflow Ditch	South Percolation Pond	Northern Surface Water Feature	North Percolation Pond	Flathead River Riparian Area	Flathead River
Constituent	**CAS Number**	**Fraction**							
TAL Metals									
Aluminum	7429-90-5	U		●	●	●	●	●	●
Aluminum	7429-90-5	F			●		●	●	
Arsenic	7440-38-2	U						●	
Arsenic	7440-38-2	F						●	
Barium	7440-39-3	U	●	●	●	●	●	●	●
Barium	7440-39-3	F	●	●	●	●	●	●	●
Beryllium	7440-41-7	U			●		●	●	
Cadmium	7440-43-9	U			●		●	●	
Cadmium	7440-43-9	F					●		
Chromium, Total	7440-47-3	U	●		●			●	
Cobalt	7440-48-4	U			●			●	
Copper	7440-50-8	U	●	●	●	●	●	●	●
Copper	7440-50-8	F			●		●	●	●
Iron	7439-89-6	U	●	●	●	●	●	●	●
Iron	7439-89-6	F			●			●	●
Lead	7439-92-1	U					●	●	
Manganese	7439-96-5	U		●	●	●		●	●
Manganese	7439-96-5	F			●			●	
Mercury	7439-97-6	U			●			●	
Nickel	7440-02-0	U					●		
Nickel	7440-02-0	F					●		●
Selenium	7782-49-2	U			●	●			
Vanadium	7440-62-2	U		●	●	●	●	●	●

Table 4-15
Summary of Preliminary Surface Water COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area			Cedar Creek	Cedar Creek Reservoir Overflow Ditch	South Percolation Pond	Northern Surface Water Feature	North Percolation Pond	Flathead River Riparian Area	Flathead River
Constituent	**CAS Number**	**Fraction**							
Zinc	7440-66-6	U					●		
Zinc	7440-66-6	F	●		●		●	●	
Other Inorganic Parameters									
Cyanide (Total)	57-12-5	U	●		●		●	●	●
Cyanide (Total)	57-12-5	F			●			●	●
Cyanide (Free)	FREE CN	U	●	●	●		NA	●	●
Cyanide (Free)	FREE CN	F		NA		NA	NA	●	●
Fluoride	16984-48-8	U	●	●	●	●	●	●	●
Fluoride	16984-48-8	F	●	●	●	●	●	NA	●
Nitrogen, Ammonia (As N)	7664-41-7	U			●				
Essential Nutrients									
Calcium	7440-70-2	U			●			●	
Calcium	7440-70-2	F			●				
Polycyclic Aromatic Hydrocarbons (PAHs)									
Benzo(A)Anthracene	56-55-3	U	NA	NA		NA	●	●	●
Benzo(A)Pyrene	50-32-8	U	NA	NA	●	NA	●	●	●
Benzo(B)Fluoranthene	205-99-2	U	NA	NA	●	NA	●	●	●
Benzo(G,H,I)Perylene	191-24-2	U	NA	NA		NA	●	●	●
Benzo(K)Fluoranthene	207-08-9	U	NA	NA		NA		●	●
Chrysene	218-01-9	U	NA	NA		NA	●	●	●
Dibenz(A,H)Anthracene	53-70-3	U	NA	NA		NA		●	●
Fluoranthene	206-44-0	U	NA	NA		NA	●	●	●
Indeno(1,2,3-C,D)Pyrene	193-39-5	U	NA	NA	●	NA	●	●	●
Phenanthrene	85-01-8	U	NA	NA		NA	●	●	●

Table 4-15
Summary of Preliminary Surface Water COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

		Exposure Area	Cedar Creek	Cedar Creek Reservoir Overflow Ditch	South Percolation Pond	Northern Surface Water Feature	North Percolation Pond	Flathead River Riparian Area	Flathead River
Constituent	**CAS Number**	**Fraction**							
Pyrene	129-00-0	U	NA	NA		NA	●	●	●
TCL Semi-Volatile Organic Compounds (TCL SVOCs)									
3- And 4- Methylphenol (Total)	MEPH3MEPH4	U	NA	NA		NA		●	
Benzaldehyde	100-52-7	U	NA	NA		NA		●	
Bis(2-Ethylhexyl) Phthalate	117-81-7	U	NA	NA		NA			●
Caprolactam	105-60-2	U	NA	NA		NA		●	●
Carbazole	86-74-8	U	NA	NA		NA		●	
Phenol	108-95-2	U	NA	NA		NA		●	
TCL Volatile Organic Compounds (TCL VOCs)									
Toluene	108-88-3	U	NA	NA		NA		●	

Notes:

● - COPEC
Blank - Constituent measured but not COPEC
F - Filtered
NA - Not Applicable, constituent was not measured
PAH - Polycyclic Aromatic Hydrocarbons
SVOC - Semi-volatile organic compound
TAL - Target Analyte List
TCL - Target Compound List
U - Unfiltered
VOC - Volatile organic compound

Table 4-16
Reference Area Selection for Ecological Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Areas	Predominant Soil Type	Secondary Soil Type	Contribution of Secondary Soil Type	Soil Reference Area for Comparison	Notes	Sediment Reference Area for Comparison	Notes	Surface Water Reference Area for Comparison	Notes
Terrestrial Exposure Areas									
Main Plant Area	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	None	NA	SO 1 (Glacial Till and Alluvium)		NA		NA	
Central Landfills Area	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	Yr; Revett Formation (Middle Proterozoic) (Teakettle Mountain)	Minor	SO 1 (Glacial Till and Alluvium)		NA		NA	
Industrial Landfill Area	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	None	NA	SO 1 (Glacial Till and Alluvium)		NA		NA	
Eastern Undeveloped Area	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	Yr; Revett Formation (Middle Proterozoic) (Teakettle Mountain)	Minor	SO 1 (Glacial Till and Alluvium)		NA		NA	
North-Central Undeveloped Area	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	Yr; Revett Formation (Middle Proterozoic) (Teakettle Mountain)	Minor	SO 1 (Glacial Till and Alluvium)		NA		NA	
Western Undeveloped Area	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	Qgl; Glacial Lake Deposit	Very Minor	SO 1 (Glacial Till and Alluvium)		NA		NA	
Flathead River Riparian Area	Qal; Alluvial Deposits (Holocene)	None	NA	Lower of SO 2 and SO 3 (Fluvial Deposits and Riverwash)	1.	NA		NA	
Transitional Exposure Areas									
North Percolation Pond Area	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	None	NA	SO 1 (Glacial Till and Alluvium)		SO 1 (Glacial Till and Alluvium)	2.	Cedar Creek	3.
Cedar Creek Reservoir Overflow Ditch	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	None	NA	SO 1 (Glacial Till and Alluvium)		Cedar Creek		Cedar Creek	3.
South Percolation Pond Area	Qal; Alluvial Deposits (Holocene)	None	NA	Lower of SO 2 and SO 3 (Fluvial Deposits and Riverwash)	1.	Lower of SO 2 and SO 3 (Fluvial Deposits and Riverwash)	1., 2.	Flathead River	3.
Northern Surface Water Feature	Qgr; Glacial and Fluvioglacial Deposits (Pleistocene)	None	NA	SO 1 (Glacial Till and Alluvium)		SO 1 (Glacial Till and Alluvium)	2.	Cedar Creek	3.
Aquatic Exposure Areas									
Flathead River	NA					Flathead River		Flathead River	
Cedar Creek	NA					Cedar Creek		Cedar Creek	
Backwater Seeps Area (Flathead River Riparian Area)									
Seeps Area	NA					Flathead River		Flathead River	

NA, not applicable

Notes:

1. Soil type at Exposure Area similar to two Reference Areas; comparison will be made to the lower (more conservative) concentration from Reference Areas SO2 and SO3.
2. Depositional sediment at these transitional areas likely more similar to surrounding soil; therefore, comparison will be made to the corresponding soil Reference Area data for site sediment.
3. Reference Area water body selected based on proximity and drainage patterns at the Site.

Qal, alluvial deposits (soils deposited by Holocene)
Qgl, glacial lake deposit (Pleistocene)
Qgr, glacial and fluvioglacial deposits (pleistocenne)
Yr, Revett formation (middle Proterozoic)

Table 4-17
Summary of Refined Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Habitat		Terrestrial											ISS	Transitional				Aquatic	
Exposure Area		Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	Flathead River (Sediment)	Cedar Creek (Sediment)
Constituent	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5
	CAS Number																		
TAL Metals																			
Antimony	7440-36-0	●		●					●	●			●						
Arsenic	7440-38-2	●	●	●	●	●	●	●	●	●			●	●		●	●		
Barium	7440-39-3		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Beryllium	7440-41-7		●	●					●	●			●		●		●	●	
Cadmium	7440-43-9	●		●	●				●	●	●	●	●						
Chromium, Total	7440-47-3	●	●	●					●	●	●		●						
Cobalt	7440-48-4			●					●										
Copper	7440-50-8	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●		
Lead	7439-92-1	●	●	●	●	●	●	●	●	●	●	●	●	●		●			
Manganese	7439-96-5		●		●	●	●	●					●	●	●	●	●		●
Mercury	7439-97-6	●			●				●		●	●							
Nickel	7440-02-0	●	●	●	●				●	●	●	●	●	●	●				
Selenium	7782-49-2	●	●	●	●		●		●	●	●		●	●		●	●		
Silver	7440-22-4									●	●	●							
Thallium	7440-28-0		●	●	●	●			●	●			●						
Vanadium	7440-62-2	●	●	●	●	●	●		●	●			●	●	●	●	●	●	
Zinc	7440-66-6	●	●	●	●	●	●	●	●	●	●	●	●	●	●				
Other Inorganic Parameters																			
Cyanide	57-12-5	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cyanide (Free)	STL00131	NA	NA	NA	NA	NA	NA		NA	NA		●	NA	NA	NA	NA	NA		NA
Fluoride	16984-48-8	●	●	●					●				●						
Dioxins and Furans																			
1,2,3,4,6,7,8-Heptachlorodibenzofuran	67562-39-4	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	35822-46-9	●	●	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,7,8,9-Heptachlorodibenzofuran	55673-89-7	●		NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,4,7,8-Hexachlorodibenzofuran	70648-26-9	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

EHS Support

Table 4-17
Summary of Refined Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	Habitat	Terrestrial											ISS	Transitional				Aquatic	
	Exposure Area	Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	Flathead River (Sediment)	Cedar Creek (Sediment)
Constituent	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5
	CAS Number																		
1,2,3,4,7,8-Hexachlorodibenzo-P-Dioxin	39227-28-6	●		NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,6,7,8-Hexachlorodibenzofuran	57117-44-9	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,6,7,8-Hexachlorodibenzo-P-Dioxin	57653-85-7	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8,9-Hexachlorodibenzo-P-Dioxin	19408-74-3	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8-Pentachlorodibenzofuran	57117-41-6	●		NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2,3,7,8-Pentachlorodibenzo-P-Dioxin	40321-76-4	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,6,7,8-Hexachlorodibenzofuran	60851-34-5	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,4,7,8-Pentachlorodibenzofuran	57117-31-4	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,7,8-Tetrachlorodibenzofuran	51207-31-9	●	●	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,3,7,8-Tetrachlorodibenzo-P-Dioxin	1746-01-6	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzofuran	39001-02-0	●	●	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Octachlorodibenzo-P-Dioxin	3268-87-9	●	●	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TEC2,3,7,8-TCDD-Bird-1/2MDL	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TEC2,3,7,8-TCDD-Bird-MDL	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TEC2,3,7,8-TCDD-Bird-Zero	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TEC2,3,7,8-TCDD-Mammal-1/2MDL	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TEC2,3,7,8-TCDD-Mammal-MDL	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TEC2,3,7,8-TCDD-Mammal-Zero	---	●	●	NA	NA	NA	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)																			
PCB-1254 (Aroclor 1254)	11097-69-1		●	NA									●						
Polychlorinated Biphenyl (PCBs)	1336-36-3		●	NA									●						
Polycyclic Aromatic Hydrocarbons (PAHs)																			
2-Methylnaphthalene	91-57-6		●						●	●			●						
Acenaphthene	83-32-9	●	●	●					●	●		●	●		●			●	●
Acenaphthylene	208-96-8									●									●
Anthracene	120-12-7	●	●						●	●		●	●		●		●	●	●
Fluoranthene	206-44-0	●	●	●					●	●		●	●		●		●	●	●

EHS Support

Table 4-17
Summary of Refined Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	Habitat	Terrestrial											ISS	Transitional				Aquatic	
	Exposure Area	Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	Flathead River (Sediment)	Cedar Creek (Sediment)
Constituent	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5
	CAS Number																		
Fluorene	86-73-7	●	●						●	●		●	●		●				●
Naphthalene	91-20-3	●	●	●				●	●	●			●		●			●	
Phenanthrene	85-01-8	●	●	●					●	●		●	●		●		●	●	●
Total LMW PAHs - 1/2MDL	---	●	●	●					●	NA		NA	●		NA		NA	NA	NA
Total LMW PAHs - MDL	---	●	●	●					●	NA		NA	●		NA		NA	NA	NA
Total LMW PAHs - Zero	---	●	●	●					●	NA		NA	●		NA		NA	NA	NA
Benzo(A)Pyrene	50-32-8	●	●						●	●		●	●		●		●	●	●
Benzo(A)Anthracene	56-55-3	●	●	●	●				●	●	●	●	●	●	●		●	●	●
Benzo(B)Fluoranthene	205-99-2	●	●	●					●	●			●						
Benzo(G,H,I)Perylene	191-24-2	●	●	●					●	●		●	●		●		●	●	●
Benzo(K)Fluoranthene	207-08-9								●	●		●	●		●			●	
Chrysene	218-01-9	●	●	●					●	●		●	●		●		●	●	●
Dibenz(A,H)Anthracene	53-70-3	●	●						●	●		●	●		●		●	●	
Indeno(1,2,3-C,D)Pyrene	193-39-5	●	●						●	●		●	●		●		●	●	●
Pyrene	129-00-0	●	●	●					●	●		●	●		●		●	●	●
Total HMW PAHs - 1/2MDL	---	●	●	●	●	●	●	●	●	NA	●	NA	●	●	NA		NA	NA	NA
Total HMW PAHs - MDL	---	●	●	●	●	●	●	●	●	NA	●	NA	●	●	NA		NA	NA	NA
Total HMW PAHs - Zero	---	●	●	●	●	●	●	●	●	NA	●	NA	●	●	NA		NA	NA	NA
Total PAHs - 1/2MDL	---	NA	NA	NA	NA	NA	NA	NA	NA	●	NA	●	NA	NA	●	NA	●	●	●
Total PAHs - MDL	---	NA	NA	NA	NA	NA	NA	NA	NA	●	NA	●	NA	NA	●	NA	●	●	●
Total PAHs - Zero	---	NA	NA	NA	NA	NA	NA	NA	NA	●	NA	●	NA	NA	●	NA	●	●	●
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																			
3- And 4- Methylphenol (Total)	106445		●		●														
4-Chloroaniline	106-47-8										●	●							
Acetophenone	98-86-2														●		●		
Benzaldehyde	100-52-7							●						●	●	●	●	●	●
Bis(2-Ethylhexyl) Phthalate	117-81-7	●	●		●	●	●		●		●		●	●					

Table 4-17
Summary of Refined Bulk Soil and Sediment COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	Habitat	Terrestrial											ISS	Transitional				Aquatic	
	Exposure Area	Main Plant (Soil)	Central Landfills (Soil)	Industrial Landfill (Soil)	Eastern Undeveloped (Soil)	North-Central Undeveloped (Soil)	Western Undeveloped (Soil)	Flathead River Riparian (Soil)	North Percolation Pond (Soil)	North Percolation Pond (Sediment)	South Percolation Pond (Soil)	South Percolation Pond (Sediment)	Incremental Soil Sample (Soil)	Cedar Creek Reservoir Overflow Ditch (Soil)	Cedar Creek Reservoir Overflow Ditch (Sediment)	Northern Surface Water Feature (Soil)	Northern Surface Water Feature (Sediment)	Flathead River (Sediment)	Cedar Creek (Sediment)
Constituent	Sample Depth (ft):	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-2	0-0.5	0-2	0-0.5	0-2	0-2	0-0.5	0-2	0-0.5	0-0.5	0-0.5
	CAS Number																		
Caprolactam	105-60-2							●											
Carbazole	86-74-8								●	●		●			●		●	●	●
Dibenzofuran	132-64-9		●						●				●						
Di-N-Butyl Phthalate	84-74-2	●	●					●			●		●	●					
TCL Volatile Organic Compounds (TCL VOCs)																			
Cyclohexane	110-82-7	●		NA	NA		●	●	●		●	●	NA	NA	NA	NA	NA	●	NA
Isopropylbenzene (Cumene)	98-82-8			NA	NA				●				NA	NA	NA	NA	NA		NA
Methyl Acetate	79-20-9	●	●	NA	NA	●	●	●	●		●		NA	NA	NA	NA	NA	●	NA
Methylcyclohexane	108-87-2	●	●	NA	NA		●	●	●		●	●	NA	NA	NA	NA	NA	●	NA
M,P-Xylene	179601-23-1	●	●	NA	NA		●	●	●		●		NA	NA	NA	NA	NA		NA
O-Xylene (1,2-Dimethylbenzene)	95-47-6	●	●	NA	NA			●	●		●		NA	NA	NA	NA	NA		NA

Notes:
Blank - Constituent measured but not COPEC
ISS - Incremental Soil Sample
MDL - Method Detection Limit
NA - Not Applicable, constituent was not measured
● - COPEC

Table 4-18
Summary of Refined Surface Water COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Fraction	North Percolation Pond	South Percolation Pond	Cedar Creek Reservoir Overflow Ditch	Northern Surface Water Feature	Flathead River	Cedar Creek
TAL Metals								
Aluminum	7429-90-5	U	●	●	●	●	●	
Aluminum	7429-90-5	F	●	●				
Barium	7440-39-3	U	●	●	●	●	●	●
Barium	7440-39-3	F	●	●	●	●	●	●
Beryllium	7440-41-7	U	●					
Copper	7440-50-8	U	●	●				
Iron	7439-89-6	U		●	●	●	●	
Iron	7439-89-6	F		●			●	
Lead	7439-92-1	U	●					
Manganese	7439-96-5	U		●	●	●	●	
Vanadium	7440-62-2	U	●	●	●	●	●	
Other Inorganic Parameters								
Cyanide (Total)	57-12-5	U	●	●			●	●
Cyanide (Total)	57-12-5	F		●			●	
Cyanide (Free)	FREE CN	U	NA	●	●		●	●
Cyanide (Free)	FREE CN	F	NA		NA	NA	●	
Fluoride	16984-48-8	F	●					
Polycyclic Aromatic Hydrocarbons (PAHs)								
Benzo(A)Anthracene	56-55-3	U	●		NA	NA		NA
Benzo(A)Pyrene	50-32-8	U	●		NA	NA		NA
Benzo(B)Fluoranthene	205-99-2	U	●		NA	NA	●	NA
Benzo(G,H,I)Perylene	191-24-2	U	●		NA	NA		NA
Chrysene	218-01-9	U	●		NA	NA		NA

Table 4-18
Summary of Refined Surface Water COPECs by Exposure Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

		Exposure Area	North Percolation Pond	South Percolation Pond	Cedar Creek Reservoir Overflow Ditch	Northern Surface Water Feature	Flathead River	Cedar Creek
Constituent	**CAS Number**	**Fraction**						
Fluoranthene	206-44-0	U	●		NA	NA		NA
Indeno(1,2,3-C,D)Pyrene	193-39-5	U	●	●	NA	NA		NA
Pyrene	129-00-0	U	●		NA	NA	●	NA
TCL Semi-Volatile Organic Compounds (TCL SVOCs)								
Bis(2-Ethylhexyl) Phthalate	117-81-7	U			NA	NA	●	NA

Notes:

● - COPEC
Blank - Constituent measured but not COPEC
F - Filtered
NA - Not Applicable, constituent was not measured
PAH - Polycyclic Aromatic Hydrocarbons
SVOC - Semi-volatile organic compound
TAL - Target Analyte List
TCL - Target Compound List
U - Unfiltered

Table 4-19
Hot Spot Evaluation for Refined COPECs Eliminated
Due to Low Frequency of Detection
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Detection Frequency	Minimum Detected Concentration	Mean Detected Concentration	Maximum Concentration	BTV Soil Background Concentration	Refined ESV	Maximum > Higher of 10x BTV or ESV?	Retain for Further Evaluation?
Main Plant Area (Soil)											
TAL Metals (mg/kg)											
Thallium	7440-28-0	152	1	1%	0.13	0.13	0.13	0.15	0.05	No	No (A)
Dioxins and Furans (mg/kg)											
1,2,3,7,8,9-Hexachlorodibenzofuran	72918-21-9	58	2	3%	5.20E-08	6.40E-08	7.70E-08	2.60E-07	ND	No	No (A)
Polychlorinated Biphenyls (PCBs) (mg/kg)											
PCB-1254 (Aroclor 1254)	11097-69-1	136	4	3%	0.056	0.073	0.11	ND	0.041	No	No (A)
Polychlorinated Biphenyl (PCBs)	1336-36-3	136	4	3%	0.056	0.073	0.11	ND	0.000332	**Yes**	No (B)
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
3- And 4- Methylphenol (Total)	106445	120	4	3%	0.011	0.023	0.036	ND	ND	NA	No (C)
Benzaldehyde	100-52-7	152	6	4%	0.0049	0.0302	0.093	0.181	ND	No	No (A)
Hexachlorobenzene	118-74-1	152	1	1%	0.091	0.091	0.091	0.012	0.079	No	No (A)
Pentachlorophenol	87-86-5	151	4	3%	0.17	0.32	0.53	0.28	0.36	No	No (A)
TCL Volatile Organic Compounds (TCL VOCs) (mg/kg)											
Isopropylbenzene (Cumene)	98-82-8	64	1	2%	0.0003	0.0003	0.0003	ND	ND	NA	No (C,D)
Central Landfill Area (Soil)											
TAL Metals (mg/kg)											
Antimony	7440-36-0	110	4	4%	0.37	0.91	1.5	0.43	0.27	No	No (A)
Cadmium	7440-43-9	110	5	5%	0.27	0.77	1.6	0.382	0.27	No	No (A)
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Caprolactam	105-60-2	110	2	2%	0.039	0.052	0.066	0.11	ND	No	No (A)
Phenol	108-95-2	110	4	4%	0.016	0.349	1.2	0.052	0.79	No	No (A)
TCL Volatile Organic Compounds (TCL VOCs) (mg/kg)											
Cyclohexane	110-82-7	27	1	4%	0.00052	0.00052	0.00052	ND	ND	NA	No (C,D)
Isopropylbenzene (Cumene)	98-82-8	27	1	4%	0.00034	0.00034	0.00034	ND	ND	NA	No (C,D)
Industrial Landfill Area (Soil): NONE											
Eastern Undeveloped Area (Soil)											
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Di-N-Butyl Phthalate	84-74-2	37	1	3%	0.22	0.22	0.22	0.075	0.011	No	No (C,D)
North-Central Undeveloped Area (Soil)											
TAL Metals (mg/kg)											
Cadmium	7440-43-9	54	2	4%	0.3	0.3	0.4	0.382	0.27	No	No (A)
Western Undeveloped Area (Soil)											
TAL Metals (mg/kg)											
Antimony	7440-36-0	82	1	1%	0.36	0.36	0.36	0.43	0.27	No	No (A)
Cadmium	7440-43-9	82	3	4%	0.48	0.64	0.78	0.382	0.27	No	No (A)
Thallium	7440-28-0	82	3	4%	0.12	0.22	0.41	0.15	0.05	No	No (A)
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Di-N-Butyl Phthalate	84-74-2	82	4	5%	0.011	0.129	0.48	0.075	0.011	No	No (A)

Table 4-19
Hot Spot Evaluation for Refined COPECs Eliminated
Due to Low Frequency of Detection
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Detection Frequency	Minimum Detected Concentration	Mean Detected Concentration	Maximum Concentration	BTV Soil Background Concentration	Refined ESV	Maximum > Higher of 10x BTV or ESV?	Retain for Further Evaluation?
Flathead River Riparian Area (Soil)											
TAL Metals (mg/kg)											
Selenium	7782-49-2	38	1	3%	0.65	0.65	0.65	1.376	0.52	No	No (A)
North Percolation Pond Area (Soil)											
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Benzyl Butyl Phthalate	85-68-7	40	1	3%	0.55	0.55	0.55	0.12	90	No	No (A)
North Percolation Pond Area (Sediment)											
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Acetophenone	98-86-2	22	1	5%	0.011	0.011	0.011	0.034	ND	No	No (A)
North Percolation Pond Area (Surface Water): NONE											
South Percolation Pond Area (Soil)											
TAL Metals (mg/kg)											
Antimony	7440-36-0	38	1	3%	0.67	0.67	0.67	0.43	0.27	No	No (A)
Thallium	7440-28-0	38	1	3%	0.2	0.2	0.2	0.15	0.05	No	No (A)
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
3- And 4- Methylphenol (Total)	106445	32	1	3%	0.13	0.13	0.13	ND	ND	NA	No (C,D)
Benzaldehyde	100-52-7	38	1	3%	0.038	0.038	0.038	0.0185	ND	No	No (A)
South Percolation Pond Area (Sediment)											
TAL Metals (mg/kg)											
Thallium	7440-28-0	26	1	4%	0.2	0.2	0.2	0.15	ND	No	No (A)
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Benzaldehyde	100-52-7	26	1	4%	0.038	0.038	0.038	0.0185	ND	No	No (A)
South Percolation Pond Area (Surface Water): NONE											
Cedar Creek Overflow Ditch Area (All Media): NONE											
Northern Surface Water Feature Area (All Media): NONE											
Flathead River (Sediment)											
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)											
Fluorene	86-73-7	32	1	3%	0.03	0.03	0.03	0.022	ND	No	No (A)
Flathead River (Surface Water)											
TAL Metals (µg/L)											
Copper - Filtered	7440-50-8	49	2	4%	3	15	26	1.9	0.12	**Yes**	No (D)
Nickel - Filtered	7440-02-0	49	2	4%	1.3	16.8	32.2	1.3	32.612	No	No (A)
Cedar Creek (All Media): NONE											

Notes:
µg/L: microgram per liter
BTV: Background threshold value
ESV: Ecological screening value
mg/kg: milligram per kilogram
NA: Not applicable; BTV and ESV values not available.
ND: No background data/ESV available
PAH: Polycyclic Aromatic Hydrocarbons
PCB: Polychlorinated Biphenyls
SVOC: Semi-Volatile Organic Compounds
TAL: Target Analyte List
TCL: Target Compound List
VOC: Volatile Organic Compounds

Basis for excluding for further evaluation:
A: Detected concentrations do not exceed criteria (i.e., maximum concentration is lower than the greater of 10-times the BTV and ESV).
B: Total PCBs data are identical to PCB-1254 (Aroclor 1254) data, which were not retained for further evaluation.
C: Neither ESVs nor BTVs are available; therefore, there is no basis to retain chemical.
D: Only one sample was detected or one result exceeds criteria; therefore, multiple samples representing a hot spot are not present.

Table 4-20
Sitewide Summary of Non-Detected Constituents in Soil with MDLs Exceeding Minimum Soil ESVs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Detection Frequency	Minimum Detection Limit	Maximum Detection Limit	Minimum ESV	Maximum ESV	Comparison of Maximum Detection Limit to ESVs	Count of Detection Limits Exceeding Maximum ESV
Pesticides (mg/kg)								
Dieldrin	60-57-1	0 / 138	0.00084	0.0029	0.00238	0.00238	**Maximum DL > Maximum ESV**	3
Endrin	72-20-8	0 / 139	0.00082	0.0028	0.0014	0.0014	**Maximum DL > Maximum ESV**	13
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)								
1,2,4,5-Tetrachlorobenzene	95-94-3	0 / 721	0.00079	8.6	2.02	2.02	**Maximum DL > Maximum ESV**	7
1,4-Dioxane (P-Dioxane)	123-91-1	0 / 721	0.0057	62	2.05	2.05	**Maximum DL > Maximum ESV**	19
2,3,4,6-Tetrachlorophenol	58-90-2	0 / 721	0.0076	83	0.199	0.199	**Maximum DL > Maximum ESV**	75
2,4,5-Trichlorophenol	95-95-4	0 / 721	0.0013	14	4	4	**Maximum DL > Maximum ESV**	6
2,4,6-Trichlorophenol	88-06-2	0 / 721	0.001	11	9.94	9.94	**Maximum DL > Maximum ESV**	1
2,4-Dinitrophenol	51-28-5	0 / 721	0.049	540	0.0609	0.0609	**Maximum DL > Maximum ESV**	718
2,4-Dinitrotoluene	121-14-2	0 / 721	0.00091	9.9	1.28	1.28	**Maximum DL > Maximum ESV**	6
2,6-Dinitrotoluene	606-20-2	0 / 721	0.0011	12	0.0328	0.0328	**Maximum DL > Maximum ESV**	121
2-Chloronaphthalene	91-58-7	0 / 721	0.00084	9.2	0.0122	0.0122	**Maximum DL > Maximum ESV**	141
2-Chlorophenol	95-57-8	0 / 721	0.00085	9.3	0.243	0.243	**Maximum DL > Maximum ESV**	17
2-Methylphenol (O-Cresol)	95-48-7	0 / 721	0.0052	57	0.67	0.67	**Maximum DL > Maximum ESV**	20
2-Nitroaniline	88-74-4	0 / 721	0.0083	91	5.3	5.3	**Maximum DL > Maximum ESV**	4
2-Nitrophenol	88-75-5	0 / 721	0.001	11	1.6	1.6	**Maximum DL > Maximum ESV**	5
3,3'-Dichlorobenzidine	91-94-1	0 / 721	0.017	190	0.646	0.646	**Maximum DL > Maximum ESV**	58
3-Nitroaniline	99-09-2	0 / 721	0.0046	51	3.16	3.16	**Maximum DL > Maximum ESV**	4
4,6-Dinitro-2-Methylphenol	534-52-1	0 / 721	0.032	340	0.144	0.144	**Maximum DL > Maximum ESV**	190
4-Chloro-3-Methylphenol	59-50-7	0 / 721	0.00086	9.4	7.95	7.95	**Maximum DL > Maximum ESV**	1
4-Nitrophenol	100-02-7	0 / 721	0.013	140	5.12	5.12	**Maximum DL > Maximum ESV**	14
Bis(2-Chloroethoxy) Methane	111-91-1	0 / 721	0.00087	9.5	0.302	0.302	**Maximum DL > Maximum ESV**	16
Hexachlorobutadiene	87-68-3	0 / 721	0.0011	12	0.0398	0.0398	**Maximum DL > Maximum ESV**	90
Hexachlorocyclopentadiene	77-47-4	0 / 721	0.00093	10	0.755	0.755	**Maximum DL > Maximum ESV**	12
Hexachloroethane	67-72-1	0 / 721	0.00094	10	0.596	0.596	**Maximum DL > Maximum ESV**	12
Nitrobenzene	98-95-3	0 / 721	0.0067	73	1.31	1.31	**Maximum DL > Maximum ESV**	10
N-Nitrosodi-N-Propylamine	621-64-7	0 / 721	0.0012	14	0.544	0.544	**Maximum DL > Maximum ESV**	14
N-Nitrosodiphenylamine	86-30-6	0 / 721	0.0061	67	0.545	0.545	**Maximum DL > Maximum ESV**	32

Notes:
ESV, Ecological Screening Value
MDL, Method Detection Limit
mg/kg, milligrams per kilograms
SVOC, Semi-Volatile Organic Compound
TCL, Target Compound List

Table 4-21
Sitewide Summary of Non-Detected Constituents in Sediment with MDLs Exceeding Sediment ESVs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Detection Frequency	Minimum Detection Limit	Maximum Detection Limit	Minimum ESV	Maximum ESV	Comparison of Maximum Detection Limit to ESVs	Count of Detection Limits Exceeding Maximum ESV
Pesticides (mg/kg)								
Aldrin	309-00-2	0 / 138	0.00078	0.0027	0.002	0.002	**Maximum DL > Maximum ESV**	4
Dieldrin	60-57-1	0 / 137	0.00084	0.0029	0.0019	0.0019	**Maximum DL > Maximum ESV**	6
Endrin	72-20-8	0 / 138	0.00082	0.0028	0.0022	0.0022	**Maximum DL > Maximum ESV**	3
Heptachlor Epoxide	1024-57-3	0 / 138	0.001	0.0044	0.0025	0.0025	**Maximum DL > Maximum ESV**	8
P,P'-DDE	72-55-9	0 / 138	0.00079	0.0032	0.0032	0.0032	**Maximum DL > Maximum ESV**	1
Toxaphene	8001-35-2	0 / 138	0.019	0.065	0.000077	0.0001	**Maximum DL > Maximum ESV**	138
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)								
2,3,4,6-Tetrachlorophenol	58-90-2	0 / 387	0.0076	83	0.0011	14.0	**Maximum DL > Maximum ESV**	20
2,4,5-Trichlorophenol	95-95-4	0 / 387	0.0013	14	0.288	0.819	**Maximum DL > Maximum ESV**	8
2,4,6-Trichlorophenol	88-06-2	0 / 387	0.001	11	0.0008	10.5	**Maximum DL > Maximum ESV**	4
2,4-Dichlorophenol	120-83-2	0 / 387	0.0014	15	0.0004	5.78	**Maximum DL > Maximum ESV**	7
2,4-Dinitrophenol	51-28-5	0 / 387	0.049	540	0.0062	0.0062	**Maximum DL > Maximum ESV**	387
2,4-Dinitrotoluene	121-14-2	0 / 387	0.00091	9.9	0.0002	2.05504	**Maximum DL > Maximum ESV**	31
2,6-Dinitrotoluene	606-20-2	0 / 387	0.0011	12	0.0398	0.0398	**Maximum DL > Maximum ESV**	70
2-Chloronaphthalene	91-58-7	0 / 387	0.00084	9.2	0.417	0.417	**Maximum DL > Maximum ESV**	7
2-Chlorophenol	95-57-8	0 / 387	0.00085	9.3	0.0001	1.54	**Maximum DL > Maximum ESV**	26
2-Methylphenol (O-Cresol)	95-48-7	0 / 387	0.0052	57	0.0119	0.0554	**Maximum DL > Maximum ESV**	79
3,3'-Dichlorobenzidine	91-94-1	0 / 387	0.017	190	0.0005	6.2738	**Maximum DL > Maximum ESV**	51
4,6-Dinitro-2-Methylphenol	534-52-1	0 / 387	0.032	340	0.104	0.104	**Maximum DL > Maximum ESV**	221
4-Bromophenyl Phenyl Ether	101-55-3	0 / 387	0.0013	14	0.0047	60.762	Maximum DL < Maximum ESV	1
4-Chloro-3-Methylphenol	59-50-7	0 / 387	0.00086	9.4	0.388	0.388	**Maximum DL > Maximum ESV**	10
4-Nitrophenol	100-02-7	0 / 387	0.013	140	0.013	0.013	**Maximum DL > Maximum ESV**	386
Atrazine	1912-24-9	0 / 387	0.008	87	0.000025	0.327	**Maximum DL > Maximum ESV**	294
Hexachlorobenzene	118-74-1	0 / 387	0.0013	14	0.02	0.02	**Maximum DL > Maximum ESV**	112
Hexachlorobutadiene	87-68-3	0 / 387	0.0011	12	0.0265	0.0265	**Maximum DL > Maximum ESV**	68
Hexachlorocyclopentadiene	77-47-4	0 / 387	0.00093	10	0.901	0.901	**Maximum DL > Maximum ESV**	7
Nitrobenzene	98-95-3	0 / 387	0.0067	73	0.145	0.145	**Maximum DL > Maximum ESV**	41
N-Nitrosodiphenylamine	86-30-6	0 / 387	0.0061	67	0.0103	132.4	Maximum DL < Maximum ESV	1
TCL Volatile Organic Compounds (TCL VOCs) (mg/kg)								
1,1-Dichloroethane	75-34-3	0 / 17	0.00021	0.0017	0.0006	0.0006	**Maximum DL > Maximum ESV**	5
Bromomethane	74-83-9	0 / 17	0.00048	0.0038	0.0014	0.0014	**Maximum DL > Maximum ESV**	5

Notes:
ESV, Ecological Screening Value
MDL, Method Detection Limit
mg/kg, milligrams per kilograms
SVOC, Semi-Volatile Organic Compound
TCL, Target Compound List
VOC, Volatile Organic Compound

Table 4-22
Sitewide Summary of Non-Detected Constituents in Surface Water with MDLs Exceeding Minimum Surface Water ESVs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Fraction	Detection Frequency	Minimum Detection Limit	Maximum Detection Limit	Minimum ESV	Maximum ESV	Comparison of Maximum Detection Limit to ESVs	Count of Detection Limits Exceeding Maximum ESV
TAL Metals (µg/L)									
Silver	7440-22-4	U	0 / 190	1.3	1.5	0.25	0.25	**Maximum DL > Maximum ESV**	190
Silver	7440-22-4	F	0 / 125	1.3	1.4	0.12	0.12	**Maximum DL > Maximum ESV**	125
Pesticides (µg/L)									
Gamma Bhc (Lindane)	58-89-9	U	0 / 4	0.004	0.012	0.01	0.01	**Maximum DL > Maximum ESV**	1
Heptachlor	76-44-8	U	0 / 4	0.003	0.004	0.0019	0.0038	**Maximum DL > Maximum ESV**	3
Heptachlor Epoxide	1024-57-3	U	0 / 4	0.004	0.005	0.0019	0.0038	**Maximum DL > Maximum ESV**	4
P,P'-DDD	72-54-8	U	0 / 4	0.005	0.006	0.001	0.001	**Maximum DL > Maximum ESV**	4
P,P'-DDE	72-55-9	U	0 / 4	0.002	0.004	0.001	0.001	**Maximum DL > Maximum ESV**	4
P,P'-DDT	50-29-3	U	0 / 4	0.004	0.004	0.0005	0.001	**Maximum DL > Maximum ESV**	4
Toxaphene	8001-35-2	U	0 / 4	0.06	0.11	0.0002	0.0002	**Maximum DL > Maximum ESV**	4
trans-Chlordane	5103-74-2	U	0 / 4	0.003	0.005	0.0043	0.0043	**Maximum DL > Maximum ESV**	3
Polychlorinated Biphenyls (PCBs) (µg/L)									
PCB-1016 (Aroclor 1016)	12674-11-2	U	0 / 4	0.098	0.1	0.000074	0.000074	**Maximum DL > Maximum ESV**	4
PCB-1221 (Aroclor 1221)	11104-28-2	U	0 / 4	0.098	0.1	0.000074	0.000074	**Maximum DL > Maximum ESV**	4
PCB-1232 (Aroclor 1232)	11141-16-5	U	0 / 4	0.098	0.1	0.000074	0.000074	**Maximum DL > Maximum ESV**	4
PCB-1242 (Aroclor 1242)	53469-21-9	U	0 / 4	0.098	0.1	0.000074	0.000074	**Maximum DL > Maximum ESV**	4
PCB-1248 (Aroclor 1248)	12672-29-6	U	0 / 4	0.098	0.1	0.000074	0.000074	**Maximum DL > Maximum ESV**	4
PCB-1254 (Aroclor 1254)	11097-69-1	U	0 / 4	0.084	0.099	0.000074	0.000074	**Maximum DL > Maximum ESV**	4
PCB-1260 (Aroclor 1260)	11096-82-5	U	0 / 4	0.084	0.099	0.000074	0.000074	**Maximum DL > Maximum ESV**	4
Polychlorinated Biphenyl (PCBs	1336-36-3	U	0 / 4	0.098	0.1	0.000074	0.014	**Maximum DL > Maximum ESV**	4
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (µg/L)									
Hexachlorobenzene	118-74-1	U	0 / 23	0.052	0.51	0.0003	0.0003	**Maximum DL > Maximum ESV**	23
Pentachlorophenol	87-86-5	U	0 / 23	0.22	2.4	0.5	16.0442415	Maximum DL < Maximum ESV	1
TCL Volatile Organic Compounds (TCL VOCs) (µg/L)									
Cis-1,3-Dichloropropene	10061-01-5	U	0 / 17	0.16	0.16	0.055	0.055	**Maximum DL > Maximum ESV**	17
Trans-1,3-Dichloropropene	10061-02-6	U	0 / 17	0.19	0.19	0.055	0.055	**Maximum DL > Maximum ESV**	17

Notes:
µg/L, microgram per liter
ESV, Ecological Screening Value
F, Filtered
MDL, Method Detection Limit
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
TAL, Target Analyte List
TCL, Target Compound List
VOC, Volatile Organic Compound
U, Unfiltered

Table 4-23
Sitewide Summary of Refined Soil COPECs Lacking Ecological Screening Values
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Detection Frequency	Minimum BTV	Maximum BTV	Minimum Concentration	Mean Concentration	Maximum Concentration
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)									
3- And 4- Methylphenol (Total)	106445	95	7	7%	---	---	0.01	0.168	1
Benzaldehyde	100-52-7	58	8	14%	0.0069	0.0237	0.031	0.059	0.1
Caprolactam	105-60-2	38	2	5%	0.0154	0.0161	0.042	0.044	0.046
TCL Volatile Organic Compounds (TCL VOCs) (mg/kg)									
Cyclohexane	110-82-7	126	46	37%	---	---	0.00039	0.00193	0.0086
Isopropylbenzene (Cumene)	98-82-8	9	2	22%	---	---	0.0002	0.00036	0.00052
Methyl Acetate	79-20-9	157	43	27%	---	---	0.0016	0.059	0.6
Methylcyclohexane	108-87-2	153	66	43%	---	---	0.00027	0.003	0.015
M,P-Xylene	179601-23-1	153	87	57%	---	---	0.000091	0.001	0.0091
O-Xylene (1,2-Dimethylbenzene)	95-47-6	136	50	37%	---	---	0.00011	0.0006	0.0051

Notes:
---, No value
BTV, Background Threshold Value
mg/kg, milligrams per kilograms
SVOC, Semi-Volatile Organic Compound
TCL, Target Compound List
VOC, Volatile Organic Compound

Table 4-24
Sitewide Summary of Refined Sediment COPECs Lacking Ecological Screening Values
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Detection Frequency	Minimum BTV	Maximum BTV	Minimum Concentration	Mean Concentration	Maximum Concentration
TAL Metals (mg/kg)									
Barium	7440-39-3	138	138	100%	55.08	154.95	19.6	246	972
Beryllium	7440-41-7	103	100	97%	0.256	0.534	0.22	0.960	17.2
Thallium	7440-28-0	51	20	39%	0.056	0.076	0.14	0.821	4.6
Vanadium	7440-62-2	103	103	100%	9.58	14.95	7.5	27.2	348
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)									
Acetophenone	98-86-2	48	4	8%	0.0006	0.0045	0.0085	0.010	0.011
Benzaldehyde	100-52-7	84	16	19%	0.0018	0.0237	0.0098	0.074	0.17
Carbazole	86-74-8	132	77	58%	0.0005	0.0031	0.0023	4.48	190
TCL Volatile Organic Compounds (TCL VOCs) (mg/kg)									
Cyclohexane	110-82-7	16	13	81%	---	---	0.00093	0.002	0.0046
Methyl Acetate	79-20-9	6	1	17%	---	---	0.11	0.11	0.11
Methylcyclohexane	108-87-2	16	13	81%	---	---	0.0014	0.005	0.0085

Notes:
---: No value
BTV: Background Threshold Value
mg/kg, milligrams per kilograms
SVOC, Semi-Volatile Organic Compound
TAL: Target Analyte List
TCL: Target Compound List
VOC, Volatile Organic Compound

Table 4-25
Sitewide Summary of Refined Surface Water COPECs Lacking Ecological Screening Values
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Fraction	Number of Samples	Number of Detections	Detection Frequency	Minimum BTV	Maximum BTV	Minimum Concentration	Mean Concentration	Maximum Concentration
TAL Metals (µg/L)										
Vanadium	7440-62-2	U	162	27	17%	0.6	0.6	1.2	6.2	46.8
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (µg/L)										
3- And 4- Methylphenol (Total)	MEPH3MEPH4	U	5	1	20%	---	---	7.5	7.5	7.5
Benzaldehyde	100-52-7	U	6	1	17%	0.053	0.054	2.3	2.3	2.3
Caprolactam	105-60-2	U	6	1	17%	0.567	1.14	0.97	0.97	0.97
Carbazole	86-74-8	U	6	2	33%	0.024	0.025	1.9	2.4	2.9

Notes:
---: No value
µg/L, microgram per liter
BTV: Background Threshold Value
F, Filtered
SVOC, Semi-Volatile Organic Compound
TAL: Target Analyte List
TCL: Target Compound List
U, Unfiltered

Table 5-1
Summary of Ecological Receptors, Assessment Endpoints, Measurement Endpoints, and Risk Questions - Terrestrial Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Ecological Receptor Category	Assessment Endpoints	Risk Questions	Focal Species/Level of Organization	Measurement Endpoints
Terrestrial Exposure Areas				
Soil Invertebrate Community	Survival, growth, and reproduction of amphibian populations to support the maintenance of viable and functional amphibian communities.	Are concentrations of site-related COPECs in surface water and sediment greater than effects thresholds for the survival, growth, or reproduction of amphibians?	Community	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms. 2) Comparisons of COPEC concentrations in sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms.
Terrestrial Plant Community	Survival, growth, and reproduction of terrestrial plant populations to support the maintenance of viable and functional terrestrial plant communities.	Are concentrations of site-related COPECs in soil greater than effects thresholds for the survival, growth, or reproduction of terrestrial plants?	Community	1) Comparisons of COPEC concentrations in surficial soil (0-2-feet bgs) to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative terrestrial plants.
Special Status Species Terrestrial Plant	Survival, growth, and reproduction of Spalding's Catchfly (*Silene spaldingii*) individuals, if present, to support the maintenance of viable and functional populations.	Are concentrations of site-related COPECs in soil greater than effects thresholds for the survival, growth, or reproduction of terrestrial plants?	Individual - Threatened	1) Comparisons of COPEC concentrations in surficial soil (0-2-feet bgs) to NOECs derived from survival, growth, and reproductive endpoints for representative terrestrial plants.
Reptiles	Survival, growth, and reproduction of reptile populations to support the maintenance of viable and functional reptilian communities.	Are concentrations of site-related COPECs in surface water and sediment greater than effects thresholds for the survival, growth, or reproduction of reptiles?	Community	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative reptilian test organisms. 2) Comparisons of COPEC concentrations in sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative reptilian test organisms.
Birds				
Carnivores	Survival, growth, and reproduction of avian carnivore populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by carnivorous birds through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	Red-tailed hawk (Buteo jamaicensis)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Invertivores	Survival, growth, and reproduction of avian invertivore populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by invertivorous birds through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	American woodcock (*Scolopax minor*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Herbivores	Survival, growth, and reproduction of avian herbivore populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by herbivorous birds through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	Mourning dove (*Zenaida macroura*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Invertivores (Special Status Species)	Survival, growth, and reproduction of Yellow-billed Cuckoo (*Coccyzus americanus*) individuals, if present, to support the maintenance of viable and functional populations.	Does the daily dose of site-related COPEC experienced by Yellow-billed Cuckoo (*Coccyzus americanus*) through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	Individual - Threatened Yellow-billed Cuckoo (*Coccyzus americanus*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.

Table 5-1
Summary of Ecological Receptors, Assessment Endpoints, Measurement Endpoints, and Risk Questions - Terrestrial Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Ecological Receptor Category	Assessment Endpoints	Risk Questions	Focal Species/Level of Organization	Measurement Endpoints
Mammals				
Carnivores	Survival, growth, and reproduction of mammalian carnivore populations to support the maintenance of viable and functional mammalian communities.	Does the daily dose of site-related COPEC experienced by carnivorous mammals through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Long-tailed weasel (*Mustela frenata*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Invertivores	Survival, growth, and reproduction of mammalian invertivore populations to support the maintenance of viable and functional mammalian communities.	Does the daily dose of site-related COPEC experienced by invertivorous mammals through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Northern short-tailed shrew (*Blarina brevicauda*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Herbivores	Survival, growth, and reproduction of mammalian herbivore populations to support the maintenance of viable and functional mammalian communities.	Does the daily dose of site-related COPEC experienced by herbivorous mammals through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Meadow vole (Microtus pennsylvanicus)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Carnivores (Special Status Species)	Survival, growth, and reproduction of Canada Lynx (*Lynx canadensis*) individuals, if present, to support the maintenance of viable and functional populations.	Does the daily dose of site-related COPEC potentially experienced by Canada Lynx through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Individual - Threatened Canada Lynx (*Lynx canadensis*)	Comparison of NOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Carnivores (Special Status Species)	Survival, growth, and reproduction of Grizzly Bear (*Ursus arctos horribilis*) individuals, if present, to support the maintenance of viable and functional populations.	Does the daily dose of site-related COPEC potentially experienced by Grizzly Bear through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Individual - Threatened Grizzly Bear (*Ursus arctos horribilis*)	Comparison of NOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Carnivores (Special Status Species)	Survival, growth, and reproduction of North American Wolverine (*Gulo gulo luscus*) individuals, if present, to support the maintenance of viable and functional populations.	Does the daily dose of site-related COPEC potentially experienced by North American Wolverine through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Individual - Proposed Threatened North American Wolverine (*Gulo gulo luscus*)	Comparison of NOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.

Notes:
bgs, Below ground surface
COPEC, Constituent of potential ecological concern
LOAEL, Lowest observed adverse effects level
LOEC, Lowest observed effect concentration
NOAEL, No observed adverse effects level
NOEC, No observed effect concentration

Table 5-2
Summary of Ecological Receptors, Assessment Endpoints, Measurement Endpoints, and Risk Questions - Transitional Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Ecological Receptor Category	Assessment Endpoints	Risk Questions	Focal Species/Level of Organization	Measurement Endpoints
Transitional Exposure Areas				
Benthic invertebrate community	Survival, growth, and reproduction of benthic macroinvertebrate populations to support the maintenance of viable and functional benthic macroinvertebrate communities.	Are concentrations of site-related COPECs in sediment, pore water, or surface water greater than effects thresholds for the survival, growth, or reproduction of benthic invertebrates?	Population	Tier 1: 1) Comparisons of COPEC concentrations in bulk sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative benthic invertebrate test organisms. 2) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative benthic invertebrate test organisms. Tier 2: 3) Comparisons of COPEC concentrations in pore water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative benthic invertebrate test organisms.
		Is the survival or growth of freshwater test organisms exposed to whole sediments from transitional exposure areas significantly lower than comparable endpoints for test organisms exposed to whole sediments from reference areas?	Population	Tier 3: 4) SQT Line of Evidence: Sediment Toxicity Testing Statistical comparisons of survival, growth, and biomass endpoints from chronic, long-term sediment toxicity testing of bulk sediments from aquatic exposure areas to comparable endpoints from reference areas.
		Is the benthic community structure in transitional exposure areas different from the benthic community structure in reference areas with similar habitat? If differences in structure are observed, are those differences explained by site-related COPEC concentrations in abiotic exposure media and/or other habitat parameters?	Community	5) SQT Line of Evidence: Benthic Invertebrate Community Analysis a) SQT Line of Evidence: Statistical comparisons of multiple metrics (e.g., richness, composition, tolerance measures) that measure the structure and function of benthic invertebrate communities between study and reference stations; statistical evaluation of the results of the multi-metric community analyses with site-related COPEC concentrations in exposure media and other habitat parameters. b) Multivariate statistical comparisons (e.g., ordination) of benthic invertebrate taxa-abundance data to evaluate the structure and function of benthic communities between exposure area and reference area stations.
Soil invertebrate community	Survival, growth, and reproduction of amphibian populations to support the maintenance of viable and functional amphibian communities.	Are concentrations of site-related COPECs in surface water and sediment greater than effects thresholds for the survival, growth, or reproduction of amphibians?	Population	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms. 2) Comparisons of COPEC concentrations in sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms.
Aquatic plant community	Survival, growth, and reproduction of aquatic plant populations to support the maintenance of viable and functional aquatic plant communities.	Are concentrations of site-related COPECs in surface water greater than effects thresholds for the survival, growth, or reproduction of aquatic plants?	Population	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative aquatic plant test organisms.

Table 5-2
Summary of Ecological Receptors, Assessment Endpoints, Measurement Endpoints, and Risk Questions - Transitional Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Ecological Receptor Category	Assessment Endpoints	Risk Questions	Focal Species/Level of Organization	Measurement Endpoints
Terrestrial plant community	Survival, growth, and reproduction of terrestrial plant populations to support the maintenance of viable and functional terrestrial plant communities.	Are concentrations of site-related COPECs in soil greater than effects thresholds for the survival, growth, or reproduction of terrestrial plants?	Population	1) Comparisons of COPEC concentrations in surficial soil (0-2-feet bgs) to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative terrestrial plants.
Amphibians	Survival, growth, and reproduction of amphibian populations to support the maintenance of viable and functional amphibian communities.	Are concentrations of site-related COPECs in surface water and sediment greater than effects thresholds for the survival, growth, or reproduction of amphibians?	Population	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms. 2) Comparisons of COPEC concentrations in sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms.
Reptiles	Survival, growth, and reproduction of reptile populations to support the maintenance of viable and functional reptilian communities.	Are concentrations of site-related COPECs in surface water and sediment greater than effects thresholds for the survival, growth, or reproduction of reptiles?	Population	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative reptilian test organisms. 2) Comparisons of COPEC concentrations in sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative reptilian test organisms.
Birds				
Terrestrial carnivores	Survival, growth, and reproduction of avian carnivore populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by carnivorous birds through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	Red-tailed hawk (Buteo jamaicensis)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Terrestrial invertivores	Survival, growth, and reproduction of avian invertivore populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by invertivorous birds through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	American woodcock (*Scolopax minor*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Terrestrial herbivores	Survival, growth, and reproduction of avian herbivore populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by herbivorous birds through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	Mourning dove (*Zenaida macroura*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Semi-Aquatic invertivore	Survival, growth, and reproduction of semi-aquatic avian invertivore populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by semi-aquatic invertivorous birds through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	American dipper (*Cinclus mexicanus*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, sediment, and surface water.

Table 5-2
Summary of Ecological Receptors, Assessment Endpoints, Measurement Endpoints, and Risk Questions - Transitional Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Ecological Receptor Category	Assessment Endpoints	Risk Questions	Focal Species/Level of Organization	Measurement Endpoints
Mammals				
Terrestrial carnivores	Survival, growth, and reproduction of mammalian carnivore populations to support the maintenance of viable and functional mammalian communities.	Does the daily dose of site-related COPEC experienced by carnivorous mammals through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Long-tailed weasel (*Mustela frenata*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Terrestrial invertivores	Survival, growth, and reproduction of mammalian invertivore populations to support the maintenance of viable and functional mammalian communities.	Does the daily dose of site-related COPEC experienced by invertivorous mammals through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Northern short-tailed shrew (*Blarina brevicauda*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Terrestrial herbivores	Survival, growth, and reproduction of mammalian herbivore populations to support the maintenance of viable and functional mammalian communities.	Does the daily dose of site-related COPEC experienced by herbivorous mammals through the direct ingestion of dietary items, incidental ingestion of soil/sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Meadow Vole (Microtus pennsylvanicus)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Carnivores (Special Status Species)	Survival, growth, and reproduction of Canada Lynx (*Lynx canadensis*) individuals, if present, to support the maintenance of viable and functional populations.	Does the daily dose of site-related COPEC potentially experienced by Canada Lynx through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Individual - Threatened Canada Lynx (*Lynx canadensis*)	Comparison of NOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Carnivores (Special Status Species)	Survival, growth, and reproduction of Grizzly Bear (*Ursus arctos horribilis*) individuals, if present, to support the maintenance of viable and functional populations.	Does the daily dose of site-related COPEC potentially experienced by Grizzly Bear through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Individual - Threatened Grizzly Bear (*Ursus arctos horribilis*)	Comparison of NOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.
Carnivores (Special Status Species)	Survival, growth, and reproduction of North American Wolverine (*Gulo gulo luscus*) individuals, if present, to support the maintenance of viable and functional populations.	Does the daily dose of site-related COPEC potentially experienced by North American Wolverine through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from transitional exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Individual - Proposed Threatened North American Wolverine (*Gulo gulo luscus*)	Comparison of NOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs in dietary items, soil, and surface water.

Notes:
bgs, Below ground surface
COPEC, Constituent of potential ecological concern
LOAEL, Lowest observed adverse effects level
LOEC, Lowest observed effect concentration
NOAEL, No observed adverse effects level
NOEC, No observed effect concentration
SQT, Sediment quality triad

Table 5-3
Summary of Ecological Receptors, Assessment Endpoints, Measurement Endpoints, and Risk Questions - Aquatic Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

<table>
<tr><th>Ecological Receptor Category</th><th>Assessment Endpoints</th><th>Risk Questions</th><th>Focal Species/Level of Organization</th><th>Measurement Endpoints</th></tr>
<tr><td colspan="5">Aquatic Exposure Areas</td></tr>
<tr><td rowspan="3">Benthic invertebrate community</td><td rowspan="3">Survival, growth, and reproduction of benthic macroinvertebrate populations to support the maintenance of viable and functional benthic macroinvertebrate communities.</td><td>Are concentrations of site-related COPECs in sediment, pore water, or surface water greater than effects thresholds for the survival, growth, or reproduction of benthic invertebrates?</td><td>Population</td><td><u>Tier 1:</u>

1) Comparisons of COPEC concentrations in bulk sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative benthic invertebrate test organisms.

2) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative benthic invertebrate test organisms.

<u>Tier 2:</u>

3) Comparisons of COPEC concentrations in pore water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative benthic invertebrate test organisms.</td></tr>
<tr><td>Is the survival or growth of freshwater test organisms exposed to whole sediments from aquatic exposure areas significantly lower than comparable endpoints for test organisms exposed to whole sediments from reference areas?</td><td>Population</td><td><u>Tier 3:</u>

4) SQT Line of Evidence: Sediment Toxicity Testing
Statistical comparisons of survival, growth, and biomass endpoints from chronic, long-term sediment toxicity testing of bulk sediments from aquatic exposure areas to comparable endpoints from reference areas.</td></tr>
<tr><td>Is the benthic community structure in aquatic exposure areas different from the benthic community structure in reference areas with similar habitat? If differences in structure are observed, are those differences explained by site-related COPEC concentrations in abiotic exposure media and/or other habitat parameters?</td><td>Community</td><td>5) SQT Line of Evidence: Benthic Invertebrate Community Analysis

a) SQT Line of Evidence: Statistical comparisons of multiple metrics (e.g., richness, composition, tolerance measures) that measure the structure and function of benthic invertebrate communities between study and reference stations; statistical evaluation of the results of the multi-metric community analyses with site-related COPEC concentrations in exposure media and other habitat parameters.

b) Multivariate statistical comparisons (e.g., ordination) of benthic invertebrate taxa-abundance data to evaluate the structure and function of benthic communities between exposure area and reference area stations.</td></tr>
<tr><td>Pelagic (water-column) invertebrates</td><td>Survival, growth, and reproduction of pelagic invertebrate populations to support the maintenance of viable and functional pelagic invertebrate communities.</td><td>Are concentrations of site-related COPECs in surface water greater than effects thresholds for the survival, growth, or reproduction of pelagic invertebrates?</td><td>Population</td><td>1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative pelagic invertebrate test organisms.</td></tr>
<tr><td>Aquatic plant community</td><td>Survival, growth, and reproduction of aquatic plant populations to support the maintenance of viable and functional aquatic plant communities.</td><td>Are concentrations of site-related COPECs in surface water greater than effects thresholds for the survival, growth, or reproduction of aquatic plants?</td><td>Population</td><td>1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative aquatic plant test organisms.

2) Comparisons of COPEC concentrations in pore water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative aquatic plant test organisms.</td></tr>
</table>

Table 5-3
Summary of Ecological Receptors, Assessment Endpoints, Measurement Endpoints, and Risk Questions - Aquatic Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Ecological Receptor Category	Assessment Endpoints	Risk Questions	Focal Species/Level of Organization	Measurement Endpoints
Fish	Survival, growth, and reproduction of fish populations to support the maintenance of viable and functional fish communities.	Are concentrations of site-related COPECs in surface water greater than effects thresholds for the survival, growth, or reproduction of fish?	Population	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative fish test organisms (DEQ-7 standards are used preferentially).
Special Status Fish (Flathead River Only)	Survival, growth, and reproduction of Bull Trout (*Salvelinus confluentus*) individuals, if present, to support the maintenance of viable and functional populations.	Are concentrations of site-related COPECs in surface water greater than effects thresholds for the survival, growth, or reproduction of Bull Trout?	Individual - Threatened	1) Comparisons of COPEC concentrations in surface water to NOECs derived from survival, growth, and reproductive endpoints for salmonids.
Amphibians	Survival, growth, and reproduction of amphibian populations to support the maintenance of viable and functional amphibian communities.	Are concentrations of site-related COPECs in surface water greater than effects thresholds for the survival, growth, or reproduction of amphibians?	Population	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms. 2) Comparisons of COPEC concentrations in pore water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative amphibian test organisms.
Reptiles	Survival, growth, and reproduction of reptile populations to support the maintenance of viable and functional reptilian communities.	Are concentrations of site-related COPECs in surface water and sediment greater than effects thresholds for the survival, growth, or reproduction of reptiles?	Population	1) Comparisons of COPEC concentrations in surface water to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative reptilian test organisms. 2) Comparisons of COPEC concentrations in sediment to NOECs and LOECs derived from survival, growth, and reproductive endpoints for representative reptilian test organisms.
Birds				
Piscivores	Survival, growth, and reproduction of semi-aquatic avian populations to support the maintenance of viable and functional avian communities.	Does the daily dose of site-related COPEC experienced by piscivorous birds through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from aquatic exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	Belted Kingfisher (*Megaceryle alcyon*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs fish tissues, sediment, and surface water.
Invertivore		Does the daily dose of site-related COPEC experienced by omnivorous birds through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from aquatic exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of avian test organisms?	American Dipper (*Cinclus mexicanus*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs fish tissues, sediment, and surface water.
Mammals				
Piscivores	Survival, growth, and reproduction of piscivorous mammalian populations to support the maintenance of viable and functional mammalian communities.	Does the daily dose of site-related COPEC experienced by piscivorous mammals through the direct ingestion of dietary items, incidental ingestion of sediment, and direct ingestion of surface water from aquatic exposure areas exceed toxicity reference values (TRVs) for the survival, growth, or reproduction of mammalian test organisms?	Mink (*Mustela vison*)	Comparison of NOAEL and LOAEL TRVs to dietary doses modeled using estimated concentrations of site-specific COPECs fish tissues, sediment, and surface water.

Notes:
COPEC, Constituent of potential ecological concern
DEQ, Department of Environmental Quality
LOAEL, Lowest observed adverse effects level
LOEC, Lowest observed effect concentration
NOAEL, No observed adverse effects level
NOEC, No observed effect concentration
SQT, Sediment quality triad
TRV, Toxicity reference values

Table 5-4
NOEC and LOEC Values Used to Evaluate Direct Contact Effects - Soil
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Soil Invertebrates			Plants		
	NOEC (mg/kg)	LOEC (mg/kg)	Source	NOEC (mg/kg)	LOEC (mg/kg)	Source
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-P-Dioxin	5	10	LANL ESL	---	---	---
Other Inorganic Parameters						
Cyanide	---	---	---	6.4	---	
Fluoride	---	---	---	---	---	---
Polychlorinated Biphenyls (PCBs)						
PCB-1254 (Aroclor 1254)	---	---	---	160	620	LANL ESL
Polychlorinated Biphenyl (PCBs)	---	---	---	160	620	LANL ESL
Polycyclic Aromatic Hydrocarbons (PAHs)						
Total HMW PAHs	29	---	ECO-SSL	---	---	---
Total LMW PAHs	18	---	ECO-SSL	---	---	---
TAL Metals						
Antimony	78	780	LANL ESL	11	58	LANL ESL
Arsenic	6.8	68	LANL ESL	18	91	LANL ESL
Barium	330	3200	LANL ESL	110	260	LANL ESL
Beryllium	40	400	LANL ESL	2.5	25	LANL ESL
Cadmium	140	760	LANL ESL	32	160	LANL ESL
Chromium, Total	3360	---	LANL PRG	3360	---	LANL PRG
Cobalt	---	---	---	13	130	LANL ESL
Copper	80	530	LANL ESL	70	490	LANL ESL
Lead	1700	8400	LANL ESL	120	570	LANL ESL
Manganese	450	4500	LANL ESL	220	1100	LANL ESL
Mercury	0.05	0.5	LANL ESL	34	64	LANL ESL
Nickel	280	1300	LANL ESL	38	270	LANL ESL
Selenium	4.1	41	LANL ESL	0.52	3	LANL ESL
Silver	---	---	---	560	2800	LANL ESL
Thallium	---	---	---	0.05	0.5	LANL ESL
Vanadium	---	---	---	60	80	LANL ESL
Zinc	120	930	LANL ESL	160	810	LANL ESL
TCL Semi-Volatile Organic Compounds (TCL SVOCs)						
3- And 4- Methylphenol (Total)	---	---	---	0.67	7	LANL ESL
4-Chloroaniline	1.8	18	LANL ESL	1	10	LANL ESL
Benzaldehyde	---	---	---	---	---	---
Bis(2-Ethylhexyl) Phthalate	---	---	---	---	---	---
Caprolactam	---	---	---	---	---	---
Carbazole	---	---	---	---	---	---
Dibenzofuran	---	---	---	6.1	61	LANL ESL
Di-N-Butyl Phthalate	---	---	---	160	600	LANL ESL

Table 5-4
NOEC and LOEC Values Used to Evaluate Direct Contact Effects - Soil
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Soil Invertebrates			Plants		
	NOEC (mg/kg)	LOEC (mg/kg)	Source	NOEC (mg/kg)	LOEC (mg/kg)	Source
TCL Volatile Organic Compounds (TCL VOCs)						
Cyclohexane	---	---	---	---	---	---
Isopropylbenzene (Cumene)	---	---	---	---	---	---
M,P-Xylene	---	---	---	100	1000	LANL ESL
Methyl Acetate	---	---	---	---	---	---
Methylcyclohexane	---	---	---	---	---	---
O-Xylene (1,2-Dimethylbenzene)	---	---	---	---	---	---

Notes:
---, Value not applicable
Eco-SSL, USEPA Ecological Soil Screening Level
HMW, High molecular weight
LANL ESL, Los Alamos National Laboratory Ecological Screening Level (LANL, 2018)
LANL PRG, Los Alamos National Laboratory Preliminary Remediation Goal (LANL, 2018)
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
TAL, Target analyte list
TCL, Target compound list

Table 5-5
NOEC and LOEC Values Used to Evaluate Direct Contact Effects - Surface Water
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fish/Herptiles			Benthic/Pelagic Invertebrates			Water Column Invertebrates			Aquatic Plants		
	NOEC (µg/L)	LOEC (µg/L)	Source	NOEC (µg/L)	LOEC (µg/L)	Source	NOEC (µg/L)	LOEC (µg/L)	Source	NOEC (µg/L)	LOEC (µg/L)	Source
Other Inorganic Parameters												
Cyanide (Total)	5.2	22	LANL ESL	5.2	22	LANL ESL	5.2	22	LANL ESL	5.2	22	LANL ESL
Cyanide (Free)	5.2	22	LANL ESL	5.2	22	LANL ESL	5.2	22	LANL ESL	5.2	22	LANL ESL
Fluoride	---	6000	Pearcy et al. 2015	1800	4100	Pearcy et al. 2015	1800	4100	Pearcy et al. 2015	66500	380000	Rai et al. 1998
Nitrogen, Ammonia (As N)	---	---	---	---	---	---	---	---	---	---	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)												
Benzo(A)Anthracene	2.227	---	EPA (2003) FCV	2.227	---	EPA (2003) FCV	2.227	---	EPA (2003) FCV	2.227	---	EPA (2003) FCV
Benzo(A)Pyrene	0.9573	---	EPA (2003) FCV	0.9573	---	EPA (2003) FCV	0.9573	---	EPA (2003) FCV	0.9573	---	EPA (2003) FCV
Benzo(B)Fluoranthene	0.6774	---	EPA (2003) FCV	0.6774	---	EPA (2003) FCV	0.6774	---	EPA (2003) FCV	0.6774	---	EPA (2003) FCV
Benzo(G,H,I)Perylene	0.4391	---	EPA (2003) FCV	0.4391	---	EPA (2003) FCV	0.4391	---	EPA (2003) FCV	0.4391	---	EPA (2003) FCV
Benzo(K)Fluoranthene	0.6415	---	EPA (2003) FCV	0.6415	---	EPA (2003) FCV	0.6415	---	EPA (2003) FCV	0.6415	---	EPA (2003) FCV
Chrysene	2.042	---	EPA (2003) FCV	2.042	---	EPA (2003) FCV	2.042	---	EPA (2003) FCV	2.042	---	EPA (2003) FCV
Dibenz(A,H)Anthracene	0.2825	---	EPA (2003) FCV	0.2825	---	EPA (2003) FCV	0.2825	---	EPA (2003) FCV	0.2825	---	EPA (2003) FCV
Indeno(1,2,3-C,D)Pyrene	0.275	---	EPA (2003) FCV	0.275	---	EPA (2003) FCV	0.275	---	EPA (2003) FCV	0.275	---	EPA (2003) FCV
Pyrene	10.11	---	EPA (2003) FCV	10.11	---	EPA (2003) FCV	10.11	---	EPA (2003) FCV	10.11	---	EPA (2003) FCV
Fluoranthene	7.109	---	EPA (2003) FCV	7.109	---	EPA (2003) FCV	7.109	---	EPA (2003) FCV	7.109	---	EPA (2003) FCV
TAL Metals												
Aluminum	87*	750*	DEQ-7	87*	750*	DEQ-7	87*	750*	DEQ-7	87*	750*	DEQ-7
Arsenic	150	340	LANL ESL	150	340	LANL ESL	150	340	LANL ESL	150	340	LANL ESL
Barium	3.9	39	LANL ESL	3.9	39	LANL ESL	3.9	39	LANL ESL	3.9	39	LANL ESL
Beryllium	0.66	6.6	LANL ESL	0.66	6.6	LANL ESL	0.66	6.6	LANL ESL	0.66	6.6	LANL ESL
Cadmium	0.25*	0.49*	DEQ-7	0.25*	0.49*	DEQ-7	0.25*	0.49*	DEQ-7	0.25*	0.49*	DEQ-7
Copper	2.85*	3.79*	DEQ-7	2.85*	3.79*	DEQ-7	2.85*	3.79*	DEQ-7	2.85*	3.79*	DEQ-7
Iron	1000	10000	LANL ESL	1000	10000	LANL ESL	1000	10000	LANL ESL	1000	10000	LANL ESL
Lead	0.545*	13.98*	DEQ-7	0.545*	13.98*	DEQ-7	0.545*	13.98*	DEQ-7	0.545*	13.98*	DEQ-7
Manganese	1300	2300	LANL ESL	1300	2300	LANL ESL	1300	2300	LANL ESL	1300	2300	LANL ESL
Nickel	16.1*	145*	DEQ-7	16.1*	145*	DEQ-7	16.1*	145*	DEQ-7	16.1*	145*	DEQ-7
Vanadium	19	190	LANL ESL	19	190	LANL ESL	19	190	LANL ESL	19	190	LANL ESL
Zinc	37*	37*	DEQ-7	37*	37*	DEQ-7	37*	37*	DEQ-7	37*	37*	DEQ-7
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
3- And 4- Methylphenol (Total)	---	---	---	---	---	---	---	---	---	---	---	---
Acetophenone	---	---	---	---	---	---	---	---	---	---	---	---
Benzaldehyde	---	---	---	---	---	---	---	---	---	---	---	---
Bis(2-Ethylhexyl) Phthalate	32	320	LANL ESL	32	320	LANL ESL	32	320	LANL ESL	32	320	LANL ESL
Caprolactam	---	---	---	---	---	---	---	---	---	---	---	---
Carbazole	---	---	---	---	---	---	---	---	---	---	---	---
Phenol	320	3200	LANL ESL	320	3200	LANL ESL	320	3200	LANL ESL	320	3200	LANL ESL
TCL Volatile Organic Compounds (TCL VOCs)												
Toluene	9.8	98	LANL ESL	9.8	98	LANL ESL	9.8	98	LANL ESL	9.8	98	LANL ESL

Notes:
---, Value not applicable
µg/L, micrograms per liter
DEQ, Department of Environmental Quality
EPA, Environmental Protection Agency
FCV, Final chronic value
LANL ESL, Los Alamos National Laboratory Ecological Screening Level (LANL, 2018)
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration
PAH, Polycyclic Aromatic Hydrocarbons
SVOC, Semi-volatile organic compound
TAL, Target analyte list
TCL, Target compound list
VOC, Volatile organic compound
Citations - see report reference list.
An asterisk (*) indicates that the NOEC and LOEC are sample specific. Default values are presented in this table.

Table 5-6
NOEC and LOEC Values Used to Evaluate Direct Contact Effects - Sediment
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Benthic Invertebrates		
	NOEC (mg/kg)	LOEC (mg/kg)	Source
Other Inorganic Parameters			
Cyanide (Total)	0.1	1	LANL ESL
Cyanide (Free)	---	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)			
2-Methylnaphthalene	$\sum ESBTU_{FCV,Total}$ = 1, protective of benthic receptors based on USEPA (2003)	$\sum ESBTU_{FCV,Total}$ = 10, indicative of frequent adverse effects to benthic receptors based on USEPA (2003)	USEPA (2003)
Acenaphthene			
Acenaphthylene			
Anthracene			
Benzo(A)Anthracene			
Benzo(A)Pyrene			
Benzo(B)Fluoranthene			
Benzo(G,H,I)Perylene			
Benzo(K)Fluoranthene			
Chrysene			
Dibenz(A,H)Anthracene			
Fluoranthene			
Fluorene			
Indeno(1,2,3-C,D)Pyrene			
Naphthalene			
Phenanthrene			
Pyrene			
Total HMW PAHs			
Total LMW PAHs			
Total PAHs			
TAL Metals			
Antimony	---	---	---
Arsenic	9.7	33	LANL ESL
Barium	150	300	LANL ESL
Beryllium	---	---	---
Cadmium	0.99	4.9	LANL ESL
Chromium, Total	43	110	LANL ESL
Copper	31	140	LANL ESL
Lead	35	120	LANL ESL
Manganese	460	1100	LANL ESL
Mercury	0.18	1	LANL ESL
Nickel	22	48	LANL ESL
Selenium	0.72	2.9	LANL ESL
Silver	0.5	5	LANL ESL
Thallium	---	---	---
Vanadium	---	---	---
Zinc	120	450	LANL ESL
TCL Semi-Volatile Organic Compounds (TCL SVOCs)			
4-Chloroaniline	---	---	---
Acetophenone	---	---	---
Benzaldehyde	---	---	---
Carbazole	---	---	---
TCL Volatile Organic Compounds (TCL VOCs)			
Cyclohexane	---	---	---
Methyl Acetate	---	---	---
Methylcyclohexane	---	---	---

Notes:
---, Value not applicable
ESBTU, Equilibrium partitioning sediment benchmark toxic unit
FCV, Final chronic value
HMW, High molecular weight
LANL ESL, Los Alamos National Laboratory Ecological Screening Level (LANL, 2018)
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
PAH, Polycyclic Aromatic Hydrocarbons
SVOC, Semi-volatile organic compound
TAL, Target analyte list
TCL, Target compound list
USEPA, United States Environmental Protection Agency
VOC, Volatile organic compound

Table 5-7
Areal Proportions Used to Evaluate Cumulative Risk for Large Range Receptors
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Species	Ecological Exposure Area	Main Plant Area	Cedar Creek Reservoir Overflow Ditch	South Percolation Pond Area	Northern Surface Water Feature	North Percolation Pond Area	Central Landfills Area	Industrial Landfill Area	Eastern Undeveloped Area	North-Central Undeveloped Area	Western Undeveloped Area	Flathead River Riparian Area	Outside of Site Boundary	Total
American Woodcock (11.1 acres)	Main Plant Area	1	0	0	0	0	0	0	0	0	0	0	0	1
	Cedar Creek Reservoir Overflow Ditch	4.4E-05	0.03366	0	0	0	0.96629	0	0	0	0	0	8.1E-06	1
	South Percolation Pond Area	0.00383	0	0.22379	0	0	0	0	0	0	0	0.6959	0.07649	1
	Northern Surface Water Feature	0	0	0	0.09953	0	0.04368	0	0	0.85678	0	0	1.1E-05	1
	North Percolation Pond Area	0	0	0	0	1	0	0	0	0	0	0	0	1
	Central Landfills Area	0	0	0	0	0	1	0	0	0	0	0	0	1
	Industrial Landfill Area	0	0	0	0	0	0	1	0	0	0	0	0	1
	Eastern Undeveloped Area	0	0	0	0	0	0	0	1	0	0	0	0	1
	North-Central Undeveloped Area	0	0	0	0	0	0	0	0	1	0	0	0	1
	Western Undeveloped Area	0	0	0	0	0	0	0	0	0	1	0	0	1
	Flathead River Riparian Area	0	0	0	0	0	0	0	0	0	0	1	0	1
Mourning Dove (1,986 acres)	Main Plant Area	0.11674	0.00213	0.00456	0.00307	0.00567	0.06838	0.00622	0.04885	0.06059	0.14722	0.04329	0.49329	1
	Cedar Creek Reservoir Overflow Ditch	0.11674	0.00242	0.00456	0.00307	0.00567	0.06838	0.00637	0.04885	0.07193	0.10814	0.03708	0.52679	1
	South Percolation Pond Area	0.11674	0.00171	0.00456	0.00257	0.00567	0.06747	0	0.04885	0.0243	0.09426	0.04371	0.59017	1
	Northern Surface Water Feature	0.10435	0.00206	0.00083	0.00307	0.00567	0.06838	0.00637	0.01756	0.07277	0.18966	0.01615	0.51314	1
	North Percolation Pond Area	0.11063	0.00206	0.00349	0.00307	0.00567	0.06838	0.00637	0.0201	0.07273	0.22131	0.04075	0.44544	1
	Central Landfills Area	0.11674	0.00261	0.00456	0.00307	0.00567	0.06838	0.00637	0.04831	0.07277	0.15352	0.03609	0.48191	1
	Industrial Landfill Area	0.07672	0.00183	0	0.00307	0.00567	0.06838	0.00637	0.00371	0.07277	0.17361	0	0.58786	1
	Eastern Undeveloped Area	0.11514	0.00183	0.00456	0	0.00183	0.06812	0	0.04885	0.01723	0.01346	0.03556	0.69342	1
	North-Central Undeveloped Area	0.09298	0.002	0	0.00307	0.00567	0.06838	0.00637	0.01253	0.07277	0.16196	0	0.57428	1
	Western Undeveloped Area	0.09203	0.00144	0.00165	0.00307	0.00567	0.06189	0.00637	0.00012	0.07226	0.22016	0.03383	0.50152	1
	Flathead River Riparian Area	0.11674	0.00167	0.00456	0.00284	0.00567	0.06501	0	0.04885	0.0271	0.15606	0.04727	0.52422	1
Red-tailed Hawk (551 acres)	Main Plant Area	0.41086	0.00321	0.01616	0	0.00673	0.14999	0	0.09046	0.02215	0.06461	0.11571	0.12013	1
	Cedar Creek Reservoir Overflow Ditch	0.25925	0.00508	0	0	0.00528	0.24489	0	0.102	0.0425	0.00686	0	0.33412	1
	South Percolation Pond Area	0.36646	0	0.01643	0	0	0	0	0.05217	0	0.004	0.12072	0.44023	1
	Northern Surface Water Feature	0.03791	0.00438	0	0.01107	0.02042	0.18641	0.02295	0	0.25957	0.29045	0	0.16684	1
	North Percolation Pond Area	0.17674	0	0	0.01107	0.02042	0.11426	0.01286	0	0.14313	0.48907	0.00242	0.03002	1
	Central Landfills Area	0.20036	0.00502	0	0.00991	0.0083	0.24648	0.00171	0.03964	0.16385	0.01576	0	0.30897	1
	Industrial Landfill Area	0	0.00422	0	0.01107	0.00982	0.10395	0.02295	0	0.25881	0.25318	0	0.33601	1
	Eastern Undeveloped Area	0.20338	0.00433	0.01046	0	0	0.04773	0	0.17606	0	0	0.0421	0.51595	1
	North-Central Undeveloped Area	0	0.00476	0	0.01107	0.00969	0.16347	0.02295	0	0.26035	0.21115	0	0.31656	1
	Western Undeveloped Area	0.05779	0	0	0.00929	0.01578	0.00333	0	0	0.1001	0.61423	0.00036	0.19911	1
	Flathead River Riparian Area	0.29373	0	0.01365	0	0	0	0	0	0	0.07579	0.12229	0.49453	1

Table 5-7
Areal Proportions Used to Evaluate Cumulative Risk for Large Range Receptors
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Species	Ecological Exposure Area	Main Plant Area	Cedar Creek Reservoir Overflow Ditch	South Percolation Pond Area	Northern Surface Water Feature	North Percolation Pond Area	Central Landfills Area	Industrial Landfill Area	Eastern Undeveloped Area	North-Central Undeveloped Area	Western Undeveloped Area	Flathead River Riparian Area	Outside of Site Boundary	Total
Yellow-billed Cuckoo (42 acres)	Main Plant Area	1	0	0	0	0	0	0	0	0	0	0	3.4E-06	1
	Cedar Creek Reservoir Overflow Ditch	0.14086	0.01757	0	0	0	0.8135	0	0.02237	0	0	0	0.0057	1
	South Percolation Pond Area	0.19725	0	0.11426	0	0	0	0	0	0	0	0.5447	0.14379	1
	Northern Surface Water Feature	0	0	0	0.05338	0	0.16259	0.04575	0	0.73827	0	0	5.5E-06	1
	North Percolation Pond Area	0.00325	0	0	0.00027	0.19789	0	0	0	0.30549	0.49307	0	4.2E-05	1
	Central Landfills Area	0	0	0	0	0	1	0	0	0	0	0	0	1
	Industrial Landfill Area	0	0	0	0.00733	0	0	0.30108	0	0.54423	0.14735	0	4.4E-06	1
	Eastern Undeveloped Area	0	0	0	0	0	0	0	1	0	0	0	0	1
	North-Central Undeveloped Area	0	0	0	0	0	0	0	0	1	0	0	0	1
	Western Undeveloped Area	0	0	0	0	0	0	0	0	0	1	0	0	1
	Flathead River Riparian Area	0	0	0	0	0	0	0	0	0	0	1	0	1
Canada Lynx (10,625 acres)	Main Plant Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	Cedar Creek Reservoir Overflow Ditch	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	South Percolation Pond Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	Northern Surface Water Feature	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	North Percolation Pond Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	Central Landfills Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	Industrial Landfill Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	Eastern Undeveloped Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	North-Central Undeveloped Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	Western Undeveloped Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
	Flathead River Riparian Area	0.02182	0.00049	0.00085	0.00057	0.00106	0.01278	0.00119	0.00913	0.0136	0.04137	0.00884	0.88829	1
Grizzly Bear (32,000 acres)	Main Plant Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	Cedar Creek Reservoir Overflow Ditch	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	South Percolation Pond Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	Northern Surface Water Feature	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	North Percolation Pond Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	Central Landfills Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	Industrial Landfill Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	Eastern Undeveloped Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	North-Central Undeveloped Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	Western Undeveloped Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1
	Flathead River Riparian Area	0.00725	0.00016	0.00028	0.00019	0.00035	0.00424	0.0004	0.00303	0.00452	0.01374	0.00293	0.96291	1

Table 5-7
Areal Proportions Used to Evaluate Cumulative Risk for Large Range Receptors
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Species	Ecological Exposure Area	Main Plant Area	Cedar Creek Reservoir Overflow Ditch	South Percolation Pond Area	Northern Surface Water Feature	North Percolation Pond Area	Central Landfills Area	Industrial Landfill Area	Eastern Undeveloped Area	North-Central Undeveloped Area	Western Undeveloped Area	Flathead River Riparian Area	Outside of Site Boundary	Total
Long-tailed Weasel (12 acres)	Main Plant Area	1	0	0	0	0	0	0	0	0	0	0	0	1
	Cedar Creek Reservoir Overflow Ditch	0.00316	0.03243	0	0	0	0.9644	0	0	0	0	0	8.1E-06	1
	South Percolation Pond Area	0.01131	0	0.21674	0	0	0	0	0	0	0	0.69068	0.08127	1
	Northern Surface Water Feature	0	0	0	0.10047	0	0.05364	0	0	0.84588	0	0	9.6E-06	1
	North Percolation Pond Area	0	0	0	0	1	0	0	0	0	0	0	0	1
	Central Landfills Area	0	0	0	0	0	1	0	0	0	0	0	0	1
	Industrial Landfill Area	0	0	0	0	0	0	1	0	0	0	0	0	1
	Eastern Undeveloped Area	0	0	0	0	0	0	0	1	0	0	0	0	1
	North-Central Undeveloped Area	0	0	0	0	0	0	0	0	1	0	0	0	1
	Western Undeveloped Area	0	0	0	0	0	0	0	0	0	1	0	0	1
	Flathead River Riparian Area	0	0	0	0	0	0	0	0	0	0	1	0	1
Meadow Vole (0.13 acre)	Main Plant Area	1	0	0	0	0	0	0	0	0	0	0	0	1
	Cedar Creek Reservoir Overflow Ditch	0	1	0	0	0	0	0	0	0	0	0	0	1
	South Percolation Pond Area	0	0	1	0	0	0	0	0	0	0	0	0	1
	Northern Surface Water Feature	0	0	0	1	0	0	0	0	0	0	0	0	1
	North Percolation Pond Area	0	0	0	0	1	0	0	0	0	0	0	0	1
	Central Landfills Area	0	0	0	0	0	1	0	0	0	0	0	0	1
	Industrial Landfill Area	0	0	0	0	0	0	1	0	0	0	0	0	1
	Eastern Undeveloped Area	0	0	0	0	0	0	0	1	0	0	0	0	1
	North-Central Undeveloped Area	0	0	0	0	0	0	0	0	1	0	0	0	1
	Western Undeveloped Area	0	0	0	0	0	0	0	0	0	1	0	0	1
	Flathead River Riparian Area	0	0	0	0	0	0	0	0	0	0	1	0	1
North American Wolverine (26,000 acres)	Main Plant Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	Cedar Creek Reservoir Overflow Ditch	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	South Percolation Pond Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	Northern Surface Water Feature	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	North Percolation Pond Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	Central Landfills Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	Industrial Landfill Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	Eastern Undeveloped Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	North-Central Undeveloped Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	Western Undeveloped Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1
	Flathead River Riparian Area	0.00892	0.0002	0.00035	0.00023	0.00043	0.00522	0.00049	0.00373	0.00556	0.01691	0.00361	0.95435	1

Table 5-7
Areal Proportions Used to Evaluate Cumulative Risk for Large Range Receptors
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Species	Ecological Exposure Area	Main Plant Area	Cedar Creek Reservoir Overflow Ditch	South Percolation Pond Area	Northern Surface Water Feature	North Percolation Pond Area	Central Landfills Area	Industrial Landfill Area	Eastern Undeveloped Area	North-Central Undeveloped Area	Western Undeveloped Area	Flathead River Riparian Area	Outside of Site Boundary	Total
Short-tailed Shrew (1 acre)	Main Plant Area	1	0	0	0	0	0	0	0	0	0	0	0	1
	Cedar Creek Reservoir Overflow Ditch	0	1	0	0	0	0	0	0	0	0	0	0	1
	South Percolation Pond Area	0	0	1	0	0	0	0	0	0	0	0	0	1
	Northern Surface Water Feature	0	0	0	1	0	0	0	0	0	0	0	0	1
	North Percolation Pond Area	0	0	0	0	1	0	0	0	0	0	0	0	1
	Central Landfills Area	0	0	0	0	0	1	0	0	0	0	0	0	1
	Industrial Landfill Area	0	0	0	0	0	0	1	0	0	0	0	0	1
	Eastern Undeveloped Area	0	0	0	0	0	0	0	1	0	0	0	0	1
	North-Central Undeveloped Area	0	0	0	0	0	0	0	0	1	0	0	0	1
	Western Undeveloped Area	0	0	0	0	0	0	0	0	0	1	0	0	1
	Flathead River Riparian Area	0	0	0	0	0	0	0	0	0	0	1	0	1

Shaded cells indicate that the receptor species home range is smaller than the target ecological exposure, and the receptor was assumed to have 100 percent exposure to that exposure area. See text for details. Please note that although the long-tailed weasel's home range of 12 acres slightly exceeds the area of the North Percolation Pond Area (11.3 acres), it was assumed that 100 percent of the weasel's exposure is derived from that exposure area.

Area of Exposure Areas[a]:

Main Plant Area	231.9	acres	Industrial Landfill Area	12.6	acres
Cedar Creek Reservoir Overflow Ditch	5.2	acres	Eastern Undeveloped Area	64.9	acres
South Percolation Pond Area	5.6	acres	North-Central Undeveloped Area	114.4	acres
Northern Surface Water Feature	6.1	acres	Western Undeveloped Area	439.6	acres
North Percolation Pond Area	11.3	acres	Flathead River Riparian Area	93.9	acres
Central Landfills Area	44.4	acres			

a, Please note that the percent inclusion values were spatially calculated assuming the receptor was placed in the geometric center of the target exposure area. Therefore, a receptor whose home range is smaller than the target exposure area may have exposure to a mixture of adjacent exposure areas and less than 100 percent exposure to the target exposure area if the assumed circular home range from that midpoint location did not fully overlap the target area and intersected adjacent areas.

Table 5-8
Soil Benchmark Values Protective of Small Range Receptors (Meadow Vole and Short-tailed Shrew)
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Analyte	Meadow Vole Soil Benchmarks		Short-tailed Shrew Soil Benchmarks		Minimum NOAEL-Based Benchmark Concentration ($C_{soil-NOAEL}$) (mg/kg, dry weight)	Minimum LOAEL-Based Benchmark Concentration ($C_{Soil-LOAEL}$) (mg/kg, dry weight)	BTV[a]			
	NOAEL-Based Benchmark Concentration ($C_{soil-NOAEL}$) (mg/kg, dry weight)	LOAEL-Based Benchmark Concentration ($C_{Soil-LOAEL}$) (mg/kg, dry weight)	NOAEL-Based Benchmark Concentration ($C_{soil-NOAEL}$) (mg/kg, dry weight)	LOAEL-Based Benchmark Concentration ($C_{Soil-LOAEL}$) (mg/kg, dry weight)			SO1	SO2	SO3	SO4
Inorganics - Metals										
Aluminum	NC	NC	NC	NC	NC	NC	1.42E+04	1.30E+04	1.42E+04	4.44E+04
Antimony	8.26E+00	4.60E+02	4.35E-01	2.04E+01	4.35E-01	2.04E+01	*4.30E-01*	*4.30E-01*	*4.30E-01*	*4.30E-01*
Arsenic	1.37E+02	5.99E+02	1.08E+02	7.46E+02	1.08E+02	5.99E+02	6.29E+00	6.29E+00	1.16E+01	1.12E+02
Barium	2.04E+03	3.26E+03	3.79E+03	6.05E+03	2.04E+03	3.26E+03	3.00E+02	3.00E+02	3.00E+02	7.34E+02
Beryllium	1.10E+01	1.50E+01	7.09E+01	8.93E+01	1.10E+01	1.50E+01	1.09E+00	1.09E+00	1.30E+00	1.30E+00
Cadmium	3.93E+01	1.21E+03	6.31E-01	9.89E+00	6.31E-01	9.89E+00	3.82E-01	3.82E-01	3.82E-01	3.82E-01
Chromium	2.96E+02	7.17E+03	5.65E+01	1.37E+03	5.65E+01	1.37E+03	1.24E+01	1.24E+01	1.59E+01	2.14E+01
Cobalt	2.38E+03	6.14E+03	4.11E+02	1.06E+03	4.11E+02	1.06E+03	7.58E+00	7.58E+00	1.02E+01	6.87E+00
Copper	7.91E+02	3.33E+04	7.94E+01	1.17E+03	7.94E+01	1.17E+03	1.79E+01	2.45E+01	2.13E+01	1.06E+02
Lead	1.28E+03	8.37E+04	1.03E+02	9.36E+03	1.03E+02	9.36E+03	1.72E+01	1.72E+01	2.29E+01	2.29E+01
Manganese	3.73E+03	1.06E+04	1.14E+04	4.18E+04	3.73E+03	1.06E+04	1.84E+03	6.72E+02	1.84E+03	1.84E+03
Mercury	2.06E+02	4.47E+03	2.67E+00	2.67E+01	2.67E+00	2.67E+01	5.97E-02	6.32E-02	6.32E-02	1.30E-01
Nickel	2.91E+02	3.70E+03	1.61E+01	1.40E+02	1.61E+01	1.40E+02	1.73E+01	1.73E+01	2.17E+01	2.17E+01
Selenium	1.73E+00	6.93E+00	1.19E+00	9.48E+00	1.19E+00	6.93E+00	1.38E+00	1.38E+00	2.20E+00	2.20E+00
Thallium	1.88E+02	5.60E+02	5.50E+01	1.64E+02	5.50E+01	1.64E+02	*1.50E-01*	*1.50E-01*	4.50E-01	4.50E-01
Vanadium	1.55E+03	3.52E+03	5.86E+02	1.33E+03	5.86E+02	1.33E+03	1.57E+01	2.10E+01	2.10E+01	1.57E+01
Zinc	3.65E+03	3.34E+04	3.07E+02	1.61E+04	3.07E+02	1.61E+04	8.29E+01	6.15E+01	1.02E+02	1.02E+02
Inorganics - Other Inorganics										
Cyanide	3.52E+04	3.52E+05	4.66E+04	4.66E+05	3.52E+04	3.52E+05	2.73E-01	1.78E-01	2.73E-01	7.93E-01
Fluoride	2.43E+03	4.47E+03	1.47E+03	2.71E+03	1.47E+03	2.71E+03	4.17E+00	*2.68E+00*	*2.68E+00*	1.13E+01
Polycholrinated Biphenyls (PCBs)										
Aroclor 1248	2.59E+00	2.59E+01	2.30E-02	2.30E-01	2.30E-02	2.30E-01				
Aroclor 1254	4.44E+00	4.44E+01	1.73E-02	1.73E-01	1.73E-02	1.73E-01				
Semi-volatile Organic Compounds (SVOCs) - Polycyclic Aromatic Hydrocarbons (PAHs)										
Acenaphthene	See LMW PAH protective concentrations						5.94E-03	5.94E-03	5.94E-03	5.94E-03
Acenaphthylene	See LMW PAH protective concentrations						7.50E-03	7.50E-03	*7.50E-03*	7.50E-03
Anthracene	See LMW PAH protective concentrations						3.26E-03	3.26E-03	3.26E-03	1.36E-02
Benzo[a]anthracene	See HMW PAH protective concentrations						1.60E-02	1.60E-02	1.58E-02	3.85E-02
Benzo[a]pyrene	See HMW PAH protective concentrations						3.17E-02	3.17E-02	2.05E-02	4.09E-01
Benzo[b]fluoranthene	See HMW PAH protective concentrations						5.89E-02	5.89E-02	3.94E-02	7.69E-01
Benzo[g,h,i]perylene	See HMW PAH protective concentrations						4.06E-02	4.06E-02	3.05E-02	5.28E-01
Benzo[k]fluoranthene	See HMW PAH protective concentrations						2.46E-02	1.25E-02	1.25E-02	8.01E-02
Chrysene	See HMW PAH protective concentrations						4.16E-02	4.16E-02	2.39E-02	5.72E-01
Dibenz(a,h)anthracene	See HMW PAH protective concentrations						6.19E-03	6.19E-03	*4.90E-03*	7.48E-02
Fluoranthene	See LMW PAH protective concentrations						3.10E-02	3.73E-02	3.73E-02	2.30E-01
Fluorene	See LMW PAH protective concentrations						2.23E-02	2.23E-02	2.23E-02	7.93E-03
Indeno[1,2,3-cd]pyrene	See HMW PAH protective concentrations						3.91E-02	2.63E-02	1.52E-02	5.63E-01
Naphthalene	See HMW PAH protective concentrations						3.35E-03	3.63E-03	3.63E-03	3.63E-03
Phenanthrene	See LMW PAH protective concentrations						2.17E-02	2.17E-02	2.17E-02	6.23E-02
Pyrene	See HMW PAH protective concentrations						3.31E-02	3.31E-02	2.78E-02	2.00E-01
Low Molecular Weight (LMW) PAHs	3.13E+04	1.77E+05	1.60E+02	8.71E+02	1.60E+02	8.71E+02	*9.51E-02*	*1.02E-01*	*1.02E-01*	*3.31E-01*
High Molecular Weight (HMW) PAH	2.45E+01	1.89E+03	1.76E+00	1.10E+02	1.76E+00	1.10E+02	*2.92E-01*	*2.67E-01*	*1.91E-01*	*3.23E+00*
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs										
1,2,4,5-Tetrachlorobenzene	NC	NC	NC	NC	NC	NC	NA	NA	NA	NA
2-Chloronaphthalene	NC	NC	NC	NC	NC	NC	NA	NA	NA	NA
Biphenyl (Diphenyl)	NC	NC	NC	NC	NC	NC	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	3.31E+03	3.31E+04	2.51E+00	2.51E+01	2.51E+00	2.51E+01	NA	NA	NA	NA
Butylbenzylphthalate	1.59E+03	1.59E+04	1.04E+02	1.04E+03	1.04E+02	1.04E+03	NA	NA	NA	NA
Dibenzofuran	NC	NC	NC	NC	NC	NC	NA	NA	NA	NA
Di-n-butyl phthalate	4.43E+03	1.47E+04	3.98E+02	1.32E+03	3.98E+02	1.32E+03	NA	NA	NA	NA

Table 5-8
Soil Benchmark Values Protective of Small Range Receptors (Meadow Vole and Short-tailed Shrew)
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Analyte	Meadow Vole Soil Benchmarks		Short-tailed Shrew Soil Benchmarks		Minimum NOAEL-Based Benchmark Concentration ($C_{soil\text{-}NOAEL}$) (mg/kg, dry weight)	Minimum LOAEL-Based Benchmark Concentration ($C_{Soil\text{-}LOAEL}$) (mg/kg, dry weight)	BTV[a]			
	NOAEL-Based Benchmark Concentration ($C_{soil\text{-}NOAEL}$) (mg/kg, dry weight)	LOAEL-Based Benchmark Concentration ($C_{Soil\text{-}LOAEL}$) (mg/kg, dry weight)	NOAEL-Based Benchmark Concentration ($C_{soil\text{-}NOAEL}$) (mg/kg, dry weight)	LOAEL-Based Benchmark Concentration ($C_{Soil\text{-}LOAEL}$) (mg/kg, dry weight)			SO1	SO2	SO3	SO4
Di-n-octyl phthalate	1.29E+04	1.29E+05	8.36E+00	8.36E+01	8.36E+00	8.36E+01	NA	NA	NA	NA
Hexachlorobenzene	1.77E+02	1.77E+03	2.96E+00	2.96E+01	2.96E+00	2.96E+01	NA	NA	NA	NA
Hexachlorobutadiene	1.78E+03	1.78E+04	1.38E+02	1.38E+03	1.38E+02	1.38E+03	NA	NA	NA	NA
Hexachlorocyclopentadiene	NC	NC	NC	NC	NC	NC	NA	NA	NA	NA
Hexachloroethane	NC	NC	NC	NC	NC	NC	NA	NA	NA	NA
Pentachlorophenol	9.43E+00	2.54E+01	5.76E+00	1.55E+01	5.76E+00	1.55E+01	NA	NA	NA	NA
Volatile Organic Compounds (VOCs)										
Methylcyclohexane	NC	NC	NC	NC	NC	NC	NA	NA	NA	NA
Dioxin/Furans										
1,2,3,4,6,7,8-HpCDD							2.17E-05	1.30E-05	4.10E-05	2.17E-05
1,2,3,4,6,7,8-HpCDF							3.58E-06	2.55E-06	3.28E-06	3.58E-06
1,2,3,4,7,8,9-HpCDF							1.90E-07	2.76E-06	1.90E-07	1.90E-07
1,2,3,4,7,8-HxCDD							4.10E-07	4.10E-07	4.10E-07	4.10E-07
1,2,3,4,7,8-HxCDF							6.34E-07	2.50E-07	6.34E-07	6.34E-07
1,2,3,6,7,8-HxCDD							1.28E-06	4.50E-07	1.28E-06	1.28E-06
1,2,3,6,7,8-HxCDF							2.18E-07	2.18E-07	2.18E-07	5.50E-07
1,2,3,7,8,9-HxCDD							1.10E-06	9.11E-07	1.10E-06	1.10E-06
1,2,3,7,8,9-HxCDF							2.60E-07	2.60E-07	2.60E-07	2.60E-07
1,2,3,7,8-PeCDD							2.86E-07	2.36E-07	3.33E-07	3.33E-07
1,2,3,7,8-PeCDF							9.20E-08	4.57E-07	9.20E-08	9.20E-08
2,3,4,6,7,8-HxCDF							1.89E-07	1.89E-07	1.89E-07	1.35E-07
2,3,4,7,8-PeCDF							1.30E-07	1.30E-07	1.30E-07	1.30E-07
2,3,7,8-TCDD							3.00E-07	3.00E-07	3.00E-07	3.00E-07
2,3,7,8-TCDF							1.30E-07	4.96E-07	1.30E-07	4.96E-07
OCDD							1.53E-04	4.09E-04	4.09E-04	1.53E-04
OCDF							1.04E-05	5.60E-06	7.84E-06	1.04E-05
$TEC_{2,3,7,8\text{-TCDD-Mammal}}$	3.49E-05	2.34E-04	1.42E-06	7.08E-06	1.42E-06	7.08E-06	1.35E-06	1.21E-06	1.67E-06	1.46E-06

Notes:
Shaded cells indicate that all values were non-detect. Value is the maximum method detection limit for all reference samples.
All values are in milligrams per kilogram (mg/kg).
a, SO1 BTVs are used to represent soil and sediment background concentrations in all exposure areas except for the Flathead River Riparian Area and the South Percolation Pond Area.
The lower of SO2 and SO3 BTVs for each chemical are used to represent soil background concentrations in the Flathead River Riparian Area and the South Percolation Pond Area.
BTV, Background threshold value
HMW, High molecular weight
LMW, Low molecular weight
LOAEL, Lowest-observed adverse effect level
NA, Not applicable; background considerations only apply to metals and PAHs
NC, Soil benchmark was not calculated due to a lack of TRVs
NOAEL, No observed adverse effect level
mg/kg, milligrams per kilogram

Table 6-1
Soil Direct Contact Exposure Estimate - Main Plant Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL$_{Mean}$ Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							NOEC$_{Inverts}$	LOEC$_{Inverts}$	Maximum EPC		Refined EPC		NOEC$_{Plants}$	LOEC$_{Plants}$	Maximum EPC		Refined EPC	
									HQ$_{NOEC}$	HQ$_{LOEC}$	HQ$_{NOEC}$	HQ$_{LOEC}$			HQ$_{NOEC}$	HQ$_{LOEC}$	HQ$_{NOEC}$	HQ$_{LOEC}$
Inorganic Chemistry																		
Cyanide	mg/kg	152	126	0.153	0.239	2.4	---	---	---	---	---	---	6.4	---	<1	---	<1	---
Fluoride	mg/kg	152	152	61	118.8	571	---	---	---	---	---	---	---	---	---	---	---	---
TAL Metals																		
Antimony	mg/kg	152	9	0.443	0.272	0.61	78	780	<1	<1	<1	<1	11	58	<1	<1	<1	<1
Arsenic	mg/kg	152	152	4	5	8.8	6.8	68	**1.3**	<1	<1	<1	18	91	<1	<1	<1	<1
Cadmium	mg/kg	152	19	1	0.354	1.7	140	760	<1	<1	<1	<1	32	160	<1	<1	<1	<1
Chromium, Total	mg/kg	154	154	12	16	80.8	3360	---	<1	---	<1	---	3360	---	<1	---	<1	---
Copper	mg/kg	152	152	15	16	52.6	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	152	152	14	22	57.7	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Mercury	mg/kg	152	130	0.023	0.021	0.27	0.05	0.5	**5.4**	<1	<1	<1	34	64	<1	<1	<1	<1
Nickel	mg/kg	152	152	18	32	140	280	1300	<1	<1	<1	<1	38	270	**3.7**	<1	<1	<1
Selenium	mg/kg	152	9	0.472	0.265	0.66	4.1	41	<1	<1	<1	<1	0.5	3	**1.3**	<1	<1	<1
Vanadium	mg/kg	152	152	12	14	31.8	---	---	---	---	---	---	60	80	<1	<1	<1	<1
Zinc	mg/kg	152	152	50	59	244	120	930	**2.0**	<1	<1	<1	160	810	**1.5**	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total LMW PAHs - 1/2MDL	mg/kg	152	145	11	40	341.6	18	---	**19.0**	---	**2.2**	---	---	---	---	---	---	---
Total LMW PAHs - MDL	mg/kg	152	145	11	40	341.9	18	---	**19.0**	---	**2.2**	---	---	---	---	---	---	---
Total LMW PAHs - Zero	mg/kg	152	145	11	40	341.4	18	---	**19.0**	---	**2.2**	---	---	---	---	---	---	---
Total HMW PAHs - 1/2MDL	mg/kg	152	145	33	124	1035	29	---	**35.7**	---	**4.3**	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	152	145	33	124	1035	29	---	**35.7**	---	**4.3**	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	152	145	33	124	1035	29	---	**35.7**	---	**4.3**	---	---	---	---	---	---	---
Dioxins and Furans (mg/kg)																		
2,3,7,8-Tetrachlorodibenzo-P-Dioxin	mg/kg	58	15	0.0000002	0.0000001	0.0000006	5.0	10	<1	<1	<1	<1	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Bis(2-Ethylhexyl) Phthalate	mg/kg	152	47	0.2680	0.532	5.8	---	---	---	---	---	---	---	---	---	---	---	---
Di-N-Butyl Phthalate	mg/kg	152	21	0.0380	0.019	0.19	---	---	---	---	---	---	160	600	<1	<1	<1	<1
TCL Volatile Organic Compounds (TCL VOCs)																		
Cyclohexane	mg/kg	64	17	0.0011	NC	0.0055	---	---	---	---	---	---	---	---	---	---	---	---
Methyl Acetate	mg/kg	64	12	0.0330	NC	0.32	---	---	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	mg/kg	64	29	0.0013	NC	0.0076	---	---	---	---	---	---	---	---	---	---	---	---
M,P-Xylene	mg/kg	64	41	0.0007	NC	0.0042	---	---	---	---	---	---	100	1000	<1	<1	---	---
O-Xylene (1,2-Dimethylbenzene)	mg/kg	64	20	0.0006	NC	0.0051	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ$_{LOEC}$, Hazard Quotient based on LOEC value
HQ$_{NOEC}$, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
LOEC$_{inverts}$, Lowest Observed Effect Concentration, invertebrates
LOEC$_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
NOEC$_{inverts}$, No Observed Effect Concentration, invertebrates
NOEC$_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL$_{Mean}$, Upper confidence limit of the mean concentration

Table 6-2
Summary of Refined Wildlife Hazard Quotients for the Main Plant Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Woodcock		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		orth American Wolverir		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																						
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.15E+00	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																						
Cyanide	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																						
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																						
Total LMW PAHs	--	--	<1	--	--	--	1.03E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	1.39E+01	1.39E+00	1.59E+00	<1	<1	--	1.97E+01	1.97E+00	<1	--	<1	<1	--	--	3.64E+00	--	--	--	<1	--	2.28E+01	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																						
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	2.79E+00	--	--	--	--	--	4.17E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																						
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																						
Total Dioxins/Furans	1.8E+00	--	--	--	--	--	2.7E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	3.4E+00	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-3
Soil Direct Contact Exposure Estimate - Central Landfills Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	110	75	0.6	1.2	13	---	---	---	---	---	---	6.4	---	**2.0**	---	<1	---
Fluoride	mg/kg	110	110	60.9	140	796	---	---	---	---	---	---	---	---	---	---	---	---
TAL Metals																		
Arsenic	mg/kg	110	110	6.22	6.566	17.9	7	68	**2.6**	<1	<1	<1	18	91	<1	<1	<1	<1
Barium	mg/kg	110	110	133.5	196.6	436	330	3200	**1.3**	<1	<1	<1	110	260	**4.0**	**1.7**	**1.8**	<1
Beryllium	mg/kg	110	108	0.6	0.6	4.7	40	400	<1	<1	<1	<1	3	25	**1.9**	<1	<1	<1
Chromium, Total	mg/kg	118	117	10.98	13.81	84.8	3360	---	<1	---	<1	---	3360	---	<1	---	<1	---
Copper	mg/kg	110	110	81.0	721	7260	80	530	**90.8**	**13.7**	**9.0**	**1.4**	70	490	**104**	**14.8**	**10.3**	**1.5**
Lead	mg/kg	110	110	12.9	14.8	63.7	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Manganese	mg/kg	110	110	455	511	1140	450	4500	**2.5**	<1	**1.1**	<1	220	1100	**5.2**	1.0	**2.3**	<1
Nickel	mg/kg	110	110	24	24	534	280	1300	**1.9**	<1	<1	<1	38	270	**14.1**	**2.0**	<1	<1
Selenium	mg/kg	110	16	0.832	0.325	3	4	41	<1	<1	<1	<1	1	3	**5.8**	1.0	<1	<1
Thallium	mg/kg	110	16	0.246	0.111	1.1	---	---	---	---	---	---	0.05	0.5	**22.0**	**2.2**	**2.2**	<1
Vanadium	mg/kg	110	110	14	15	151	---	---	---	---	---	---	60	80	**2.5**	**1.9**	<1	<1
Zinc	mg/kg	110	110	49.5	56.0	114	120	930	<1	<1	<1	<1	160	810	<1	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total LMW PAHs - 1/2MDL	mg/kg	110	108	12	54	596	18	---	**33**	---	**3.0**	---	---	---	---	---	---	---
Total LMW PAHs - MDL	mg/kg	110	108	12	54	596	18	---	**33**	---	**3.0**	---	---	---	---	---	---	---
Total LMW PAHs - Zero	mg/kg	110	108	12	54	596	18	---	**33**	---	**3.0**	---	---	---	---	---	---	---
Total HMW PAHs - 1/2MDL	mg/kg	110	109	21	87	789	29	---	**27**	---	**3.0**	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	110	109	21	87	789	29	---	**27**	---	**3.0**	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	110	109	21	87	789	29	---	**27**	---	**3.0**	---	---	---	---	---	---	---
Dioxins and Furans (mg/kg)																		
2,3,7,8-Tetrachlorodibenzo-P-Dioxin	mg/kg	4	1	0.0000003	NC	0.0000003	5.0	10	<1	<1	---	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
3- And 4- Methylphenol (Total)	mg/kg	54	4	0.27	NC	1	---	---	---	---	---	---	0.7	7	**1.5**	<1	---	---
Bis(2-Ethylhexyl) Phthalate	mg/kg	110	14	0.25	0.279	2.5												
Dibenzofuran	mg/kg	110	52	0.5	1.0	15	---	---	---	---	---	---	6.1	61	**2.5**	<1	<1	<1
Di-N-Butyl Phthalate	mg/kg	110	6	0.033	0.016	0.056	---	---	---	---	---	---	160	600	<1	<1	<1	<1
TCL Volatile Organic Compounds (TCL VOCs)																		
Methyl Acetate	mg/kg	27	7	0.0088	NC	0.017	---	---	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	mg/kg	27	5	0.0007	NC	0.001	---	---	---	---	---	---	---	---	---	---	---	---
M,P-Xylene	mg/kg	27	10	0.0006	NC	0.0038	---	---	---	---	---	---	100	1000	<1	<1	---	---
O-Xylene (1,2-Dimethylbenzene)	mg/kg	27	2	0.0009	NC	0.0016	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-4
Summary of Refined Wildlife Hazard Quotients for the Central Landfill Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Woodcock		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		North American Wolverine		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																				
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	1.13E+01	1.32E+00	<1	--	--	--	1.45E+01	1.69E+00	--	--	--	--	--	--	--	--	--	--	2.43E+00	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	3.74E+00	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																				
Cyanide	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																				
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	2.07E+01	2.07E+00	--	--	--	--	3.09E+01	3.09E+00	--	--	<1	--	--	--	--	--	--	--	5.93E+00	--
Polycyclic Aromatic Hydrocarbons (PAHs)																				
Total LMW PAHs	--	--	<1	--	--	--	1.41E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	9.72E+00	--	1.59E+00	<1	<1	--	1.38E+01	1.38E+00	<1	--	<1	<1	--	--	4.99E+00	--	<1	--	3.34E+01	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																				
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	1.46E+00	--	--	--	--	--	2.19E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																				
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																				
Total Dioxins/Furans	--	--	--	--	--	--	1.10E+00	--	--	--	--	--	--	--	--	--	--	--	2.88E+00	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HQ, Hazard quotient
HQ_{LOAEL}, Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
HQ_{NOAEL}, Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-5
Soil Direct Contact Exposure Estimate - Incremental Soil Sampling (ISS) Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Chemical	Units	Number of Samples	Number of Detections	Mean Detected Concentration[1]	Maximum Detected Concentration[1]	Soil Invertebrate Communities						Terrestrial Plant Communities					
						$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		# Samples Exceeding		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		# Samples Exceeding	
								HQ_{NOEC}	HQ_{LOEC}	NOEC	LOEC			HQ_{NOEC}	HQ_{LOEC}	NOEC	LOEC
Other Inorganic Parameters (mg/kg unless otherwise noted)																	
Cyanide	mg/kg	86	84	1.2	25.5	---	---	---	---	0	0	6.4	---	**4.0**	---	1	0
Fluoride	mg/kg	86	86	332.5	1218	---	---	---	---	0	0	---	---	---	---	0	0
TAL Metals (mg/kg)																	
Antimony	mg/kg	86	75	0.8	11.0	78.0	780	<1	<1	0	0	11.0	58	1.0	<1	1	0
Arsenic	mg/kg	86	86	7.0	35.6	6.8	68	**5.2**	<1	19	0	18.0	91	**2.0**	<1	2	0
Barium	mg/kg	86	86	159.1	329.9	330.0	3200	<1	<1	0	0	110.0	260	**3.0**	**1.3**	73	9
Beryllium	mg/kg	86	86	0.9	3.9	40.0	400	<1	<1	0	0	2.5	25	**1.6**	<1	1	0
Cadmium	mg/kg	86	86	0.3	1.8	140.0	760	<1	<1	0	0	32.0	160	<1	<1	0	0
Chromium, Total	mg/kg	86	86	23.1	58.6	3360	---	<1	---	0	0	3360	---	<1	---	0	0
Cobalt	mg/kg	86	86	6.6	14.0	---	---	---	---	0	0	13.0	130	**1.1**	<1	1	0
Copper	mg/kg	86	86	69.5	995.9	80.0	530	**12.4**	**1.9**	9	2	70.0	490	**14.2**	**2.0**	11	3
Lead	mg/kg	86	86	46.5	603.0	1700	8400	<1	<1	0	0	120.0	570	**5.0**	**1.1**	4	0
Manganese	mg/kg	86	86	521.7	902.5	450.0	4500	**2.0**	<1	67	0	220.0	1100	**4.1**	<1	86	0
Mercury	mg/kg	86	60	0.0	0.1	0.1	1	**2.8**	<1	3	0	34.0	64	<1	<1	0	0
Nickel	mg/kg	86	86	33.4	162.6	280.0	1300	<1	<1	0	0	38.0	270	**4.3**	<1	23	0
Selenium	mg/kg	86	86	1.7	16.0	4.1	41	**3.9**	<1	4	0	0.5	3	**30.7**	**5.3**	74	6
Thallium	mg/kg	86	86	0.1	0.5	---	---	---	---	0	0	0.1	1	**9.1**	<1	86	0
Vanadium	mg/kg	86	86	20.1	59.5	---	---	---	---	0	0	60.0	80	<1	<1	0	0
Zinc	mg/kg	86	86	125.3	1938.6	120.0	930	**16.2**	**2.1**	12	2	160.0	810	**12.1**	**2.4**	7	2
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)																	
Total LMW PAHs - 1/2MDL	mg/kg	86	86	73.3	2339	18.0	---	**129.9**	---	27	0	---	---	---	---	0	0
Total LMW PAHs - MDL	mg/kg	86	86	73.3	2339	18.0	---	**129.9**	---	27	0	---	---	---	---	0	0
Total LMW PAHs - Zero	mg/kg	86	86	73.3	2339	18.0	---	**129.9**	---	27	0	---	---	---	---	0	0
Total HMW PAHs - 1/2MDL	mg/kg	86	86	133.3	3263	29.0	---	**112.5**	---	41	0	---	---	---	---	0	0
Total HMW PAHs - MDL	mg/kg	86	86	133.3	3263	29.0	---	**112.5**	---	41	0	---	---	---	---	0	0
Total HMW PAHs - Zero	mg/kg	86	86	133.3	3263	29.0	---	**112.5**	---	41	0	---	---	---	---	0	0
Polychlorinated Biphenyls (PCBs) (mg/kg)																	
PCB-1248 (Aroclor 1248)	mg/kg	86	1	0.2	0.2	---	---	---	---	0	0	160.0	620	<1	<1	0	0
PCB-1254 (Aroclor 1254)	mg/kg	86	14	0.4	1.7	---	---	---	---	0	0	160.0	620	<1	<1	0	0
Polychlorinated Biphenyl (PCBs)	mg/kg	86	15	0.4	1.7	---	---	---	---	0	0	160.0	620	<1	<1	0	0
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)																	
2,4-Dimethylphenol	mg/kg	86	2	0.5	0.7	---	---	---	---	0	0	0.01	---	**71.0**	---	0	0
Bis(2-Ethylhexyl) Phthalate	mg/kg	86	16	0.1	0.8	---	---	---	---	0	0	---	---	---	---	0	0
Carbazole	mg/kg	86	84	4.1	137.4	---	---	---	---	0	0	---	---	---	---	0	0
Dibenzofuran	mg/kg	86	78	2.3	93.5	---	---	---	---	0	0	6.1	61	**15.3**	**1.5**	4	1
Di-N-Butyl Phthalate	mg/kg	86	22	0.0	0.1	---	---	---	---	0	0	160.0	600	<1	<1	0	0

Notes:
[1]: The upper RSD-adjusted results are displayed.
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value

Table 6-6
Soil Direct Contact Exposure Estimate - Industrial Landfill Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	6	1	0.2	NC	0.19	---	---	---	---	---	---	6.4	---	<1	---	---	---
Fluoride	mg/kg	6	6	79.0	358	398	---	---	---	---	---	---	---	---	---	---	---	---
TAL Metals																		
Antimony	mg/kg	6	3	1.15	NC	2.8	78	780	<1	<1	---	---	11	58	<1	<1	---	---
Arsenic	mg/kg	6	6	9.0	21.8	23.5	7	68	**3.5**	<1	**3.2**	<1	18	91	**1.3**	<1	**1.2**	<1
Barium	mg/kg	6	6	123	221	227	330	3200	<1	<1	<1	<1	110	260	**2.1**	<1	**2.0**	<1
Beryllium	mg/kg	6	6	1.60	6.49	7.2	40	400	<1	<1	<1	<1	3	25	**2.9**	<1	**2.6**	<1
Cadmium	mg/kg	6	2	0.7	NC	0.94	140	760	<1	<1	---	---	32	160	<1	<1	---	---
Chromium, Total	mg/kg	6	6	16.0	35.8	39.2	3360	---	<1	---	<1	---	3360	---	<1	---	<1	---
Cobalt	mg/kg	6	6	7	11	16	---	---	---	---	---	---	13	130	**1.2**	<1	<1	<1
Copper	mg/kg	6	6	23	51	54.6	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	6	6	13	17	19.4	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Nickel	mg/kg	6	6	99	418	463	280	1300	**1.7**	<1	**1.5**	<1	38	270	**12.2**	**1.7**	**11.0**	**1.5**
Selenium	mg/kg	6	3	0.500	NC	0.75	4	41	<1	<1	---	---	1	3	**1.4**	<1	---	---
Thallium	mg/kg	6	2	0.155	NC	0.17	---	---	---	---	---	---	0	1	**3.4**	<1	---	---
Vanadium	mg/kg	6	6	41	153	169	---	---	---	---	---	---	60	80	**2.8**	**2.1**	**2.6**	**1.9**
Zinc	mg/kg	6	6	54.6	65.0	67	120	930	<1	<1	<1	<1	160	810	<1	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total LMW PAHs - 1/2MDL	mg/kg	6	6	29	117	126	18	---	**7.0**	---	**6.5**	---	---	---	---	---	---	---
Total LMW PAHs - MDL	mg/kg	6	6	29	117	126	18	---	**7.0**	---	**6.5**	---	---	---	---	---	---	---
Total LMW PAHs - Zero	mg/kg	6	6	29	117	126	18	---	**7.0**	---	**6.5**	---	---	---	---	---	---	---
Total HMW PAHs - 1/2MDL	mg/kg	6	6	97	375	388	29	---	**13.4**	---	**12.9**	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	6	6	97	375	388	29	---	**13.4**	---	**12.9**	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	6	6	97	375	388	29	---	**13.4**	---	**12.9**	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-7
Summary of Refined Wildlife Hazard Quotients for the Industrial Landfill Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Woodcock		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		North American Wolverine		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																				
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	6.60E+00	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.63E+00	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	6.72E+00	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	5.69E+00	2.05E+00	--	--	--	--	2.31E+00	<1	--	--	--	--	--	--	1.45E+00	--	--	--	2.81E+01	3.23E+00
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	5.93E+00	1.20E+00	<1	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																				
Cyanide	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																				
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																				
Total LMW PAHs	1.93E+00	--	<1	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	3.54E+01	3.54E+00	1.49E+00	<1	<1	--	1.51E+01	1.51E+00	<1	--	<1	<1	--	--	6.95E+00	--	<1	--	3.82E+01	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																				
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																				
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																				
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-8
Soil Direct Contact Exposure Estimate - Eastern Undeveloped Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	37	21	0.2	0.3	0.64	---	---	---	---	---	---	6.4	---	<1	---	<1	---
TAL Metals																		
Arsenic	mg/kg	37	37	5.35	6.38	12.4	7	68	**1.8**	<1	<1	<1	18	91	<1	<1	<1	<1
Barium	mg/kg	37	37	371	579	1060	330	3200	**3.2**	<1	**1.8**	<1	110	260	**9.6**	**4.1**	**5.3**	**2.2**
Cadmium	mg/kg	37	6	1	0	0.7	140	760	<1	<1	<1	<1	32	160	<1	<1	<1	<1
Copper	mg/kg	37	37	11.1	13.3	25.5	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	37	37	13.4	18	36.2	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Manganese	mg/kg	37	37	818	1443	3950	450	4500	**8.8**	<1	**3.2**	<1	220	1100	**18.0**	**3.6**	**6.6**	**1.3**
Mercury	mg/kg	37	34	0.028	0.046	0.12	0.05	1	**2.4**	<1	<1	<1	34	64	<1	<1	<1	<1
Nickel	mg/kg	37	37	18	41	68.9	280	1300	<1	<1	<1	<1	38	270	**1.8**	<1	**1.1**	<1
Selenium	mg/kg	37	2	0.58	NC	0.64	4	41	<1	<1	---	---	0.5	3.0	**1.2**	<1	---	---
Thallium	mg/kg	37	7	0.13	0.12	0.15	---	---	---	---	---	---	0.05	0.5	**3.0**	<1	**2.3**	<1
Vanadium	mg/kg	37	37	12.3	16.5	25.7	---	---	---	---	---	---	60	80	<1	<1	<1	<1
Zinc	mg/kg	37	37	58.9	80.4	150	120	930	**1.3**	<1	<1	<1	160	810	<1	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total HMW PAHs - 1/2MDL	mg/kg	37	37	3	7	21	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	37	37	3	7	21	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	37	37	3	7	21	29	---	<1	---	<1	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
3- And 4- Methylphenol (Total)	mg/kg	7	2	0.04	NC	0.068	---	---	---	---	---	---	0.7	7	<1	<1	---	---
Bis(2-Ethylhexyl) Phthalate	mg/kg	37	8	0.09	NC	0.15	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-9
Summary of Refined Wildlife Hazard Quotients for the Eastern Undeveloped Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Woodcock		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		North American Wolverine		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																				
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.01E+00	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																				
Cyanide	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																				
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																				
Total LMW PAHs	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	--	--	<1	<1	--	--	--	--	<1	--	<1	<1	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																				
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	1.18E+00	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																				
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																				
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOAEL}, Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
HQ_{NOAEL}, Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-10
Soil Direct Contact Exposure Estimate - North-Central Undeveloped Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	54	26	0.2	0.2	0.42	---	---	---	---	---	---	6.4	---	<1	---	<1	---
TAL Metals																		
Arsenic	mg/kg	54	54	6.03	6.26	15.3	7	68	**2.3**	<1	<1	<1	18	91	<1	<1	<1	<1
Barium	mg/kg	54	54	209	295	482	330	3200	**1.5**	<1	<1	<1	110	260	**4.4**	**1.9**	**2.7**	**1.1**
Copper	mg/kg	54	54	13	14	26.7	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	54	54	11.6	12.9	21.8	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Manganese	mg/kg	54	54	585.8	1140	2620	450	4500	**5.8**	<1	**2.5**	<1	220	1100	**11.9**	**2.4**	**5.2**	1.0
Thallium	mg/kg	54	3	0.14	NC	0.19	---	---	---	---	---	---	0	1	**3.8**	<1	---	---
Vanadium	mg/kg	54	54	11.6	13.4	20.4	---	---	---	---	---	---	60	80	<1	<1	<1	<1
Zinc	mg/kg	54	54	55	68	116	120	930	<1	<1	<1	<1	160	810	<1	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total HMW PAHs - 1/2MDL	mg/kg	54	49	0.523	1.14	4.14	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	54	49	0.528	1.14	4.14	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	54	49	0.518	1.14	4.14	29	---	<1	---	<1	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Bis(2-Ethylhexyl) Phthalate	mg/kg	54	21	0.16	0.121	0.66	---	---	---	---	---	---	---	---	---	---	---	---
TCL Volatile Organic Compounds (TCL VOCs)																		
Methyl Acetate	mg/kg	4	3	0.09	NC	0.27	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-11
Summary of Refined Wildlife Hazard Quotients for the North-Central Undeveloped Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		North American Wolverine		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																						
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																						
Cyanide	--	--	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																						
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																						
Total LMW PAHs	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	--	--	--	--	1.53E+00	<1	<1	--	--	--	<1	--	<1	<1	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																						
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																						
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																						
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOAEL}, Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
HQ_{NOAEL}, Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-12
Soil Direct Contact Exposure Estimate - Western Undeveloped Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	82	55	0.2	0.4	2.2	---	---	---	---	---	---	6.4	---	<1	---	<1	---
TAL Metals																		
Arsenic	mg/kg	82	82	5.27	5.98	15.8	7	68	**2.3**	<1	<1	<1	18	91	<1	<1	<1	<1
Barium	mg/kg	82	82	249	307	533	330	3200	**1.6**	<1	<1	<1	110	260	**4.8**	**2.1**	**2.8**	**1.2**
Copper	mg/kg	82	82	16	18	33.2	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	82	82	12.4	15.6	44.8	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Manganese	mg/kg	82	82	426.8	626	2210	450	4500	**4.9**	<1	**1.4**	<1	220	1100	**10.0**	**2.0**	**2.8**	<1
Selenium	mg/kg	82	23	0.62	0	1.1	4	41	<1	<1	<1	<1	1	3	**2.1**	<1	<1	<1
Vanadium	mg/kg	82	82	11.9	12.9	21.4	---	---	---	---	---	---	60	80	<1	<1	<1	<1
Zinc	mg/kg	82	82	51	67	238	120	930	**2.0**	<1	<1	<1	160	810	**1.5**	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total HMW PAHs - 1/2MDL	mg/kg	82	54	0.399	0.73	2.50	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	82	54	0.411	0.74	2.50	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	82	54	0.387	0.73	2.50	29	---	<1	---	<1	---	---	---	---	---	---	---
Dioxins and Furans (mg/kg)																		
2,3,7,8-Tetrachlorodibenzo-P-Dioxin	mg/kg	20	4	0.0000006	NC	0.0000018	5.0	10	<1	<1	---	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Bis(2-Ethylhexyl) Phthalate	mg/kg	82	13	0.13	0.049	0.35	---	---	---	---	---	---	---	---	---	---	---	---
TCL Volatile Organic Compounds (TCL VOCs)																		
Cyclohexane	mg/kg	17	1	0.00	NC	0.001	---	---	---	---	---	---	---	---	---	---	---	---
Methyl Acetate	mg/kg	17	10	0.08	NC	0.4	---	---	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	mg/kg	17	1	0.00	NC	0.0015	---	---	---	---	---	---	---	---	---	---	---	---
M,P-Xylene	mg/kg	17	1	0.00	NC	0.00051	---	---	---	---	---	---	100	1000	<1	<1	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-13
Summary of Refined Wildlife Hazard Quotients for the Western Undeveloped Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Woodcock		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		North American Wolverine		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																				
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																				
Cyanide	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																				
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																				
Total LMW PAHs	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	--	--	1.52E+00	<1	<1	--	--	--	<1	--	<1	<1	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																				
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																				
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																				
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1.12E+00	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-14
Soil Direct Contact Exposure Estimate - Flathead River Riparian Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	38	25	0.773	0.876	3.7	---	---	---	---	---	---	6.4	---	<1	---	<1	---
TAL Metals																		
Arsenic	mg/kg	38	38	4.5	4.9	8.2	7	68	**1.2**	<1	<1	<1	18	91	<1	<1	<1	<1
Barium	mg/kg	38	38	131	158	236	330	3200	<1	<1	<1	<1	110	260	**2.1**	<1	**1.4**	<1
Copper	mg/kg	38	38	15.2	17.1	22.7	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	38	38	9	10	13.6	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Manganese	mg/kg	38	38	301	363	467	450	4500	1.0	<1	<1	<1	220	1100	**2.1**	<1	**1.6**	<1
Zinc	mg/kg	38	38	42	47	56.3	120	930	<1	<1	<1	<1	160	810	<1	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total HMW PAHs - 1/2MDL	mg/kg	38	27	0.737	1.32	3.4	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	38	27	0.766	1.43	3.4	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	38	27	0.708	1.31	3.4	29	---	<1	---	<1	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Benzaldehyde	mg/kg	38	4	0.0518	0.039	0.088	---	---	---	---	---	---	---	---	---	---	---	---
Caprolactam	mg/kg	38	2	0.0440	NC	0.046	---	---	---	---	---	---	---	---	---	---	---	---
Di-N-Butyl Phthalate	mg/kg	38	4	0.0215	NC	0.034	---	---	---	---	---	---	160	600	<1	<1	---	---
TCL Volatile Organic Compounds (TCL VOCs)																		
Cyclohexane	mg/kg	19	18	0.0023	NC	0.005	---	---	---	---	---	---	---	---	---	---	---	---
Methyl Acetate	mg/kg	19	3	0.3237	NC	0.6	---	---	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	mg/kg	19	19	0.0042	NC	0.011	---	---	---	---	---	---	---	---	---	---	---	---
M,P-Xylene	mg/kg	19	19	0.0014	NC	0.0033	---	---	---	---	---	---	100	1000	<1	<1	---	---
O-Xylene (1,2-Dimethylbenzene)	mg/kg	19	18	0.0005	NC	0.0011	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-15
Summary of Refined Wildlife Hazard Quotients for the Flathead River Riparian Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Woodcock		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		North American Wolverine		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																				
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																				
Cyanide	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																				
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																				
Total LMW PAHs	--	--	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	--	--	1.54E+00	<1	--	--	--	--	<1	--	<1	<1	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																				
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																				
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																				
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-16
Soil Direct Contact Exposure Estimate - North Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	42	41	13.6	41.2	137	---	---	---	---	---	---	6.4	---	**21.4**	---	**6.4**	---
Fluoride	mg/kg	42	42	86.4	147	306	---	---	---	---	---	---	---	---	---	---	---	---
TAL Metals																		
Antimony	mg/kg	42	10	1.45	0.930	2.6	78	780	<1	<1	<1	<1	11	58	<1	<1	<1	<1
Arsenic	mg/kg	42	42	11.0	13.5	34.1	7	68	**5.0**	<1	**2.0**	<1	18	91	**1.9**	<1	<1	<1
Barium	mg/kg	42	42	212	245	1560	330	3200	**4.7**	<1	<1	<1	110	260	**14.2**	**6.0**	**2.2**	<1
Beryllium	mg/kg	42	42	2.71	3.99	17.2	40	400	<1	<1	<1	<1	3	25	**6.9**	<1	**1.6**	<1
Cadmium	mg/kg	42	36	2.48	3.62	9.6	140	760	<1	<1	<1	<1	32	160	<1	<1	<1	<1
Chromium, Total	mg/kg	46	46	21.7	28.7	53	3360	---	<1	---	<1	---	3360	---	<1	---	<1	---
Cobalt	mg/kg	42	42	6.64	9.47	27.4	---	---	---	---	---	---	13	130	**2.1**	<1	<1	<1
Copper	mg/kg	42	42	28	44	83.6	80	530	1.0	<1	<1	<1	70	490	**1.2**	<1	<1	<1
Lead	mg/kg	42	42	48	111	238	1700	8400	<1	<1	<1	<1	120	570	**2.0**	<1	<1	<1
Mercury	mg/kg	42	32	0.035	0.063	0.12	0.05	0.5	**2.4**	<1	**1.3**	<1	34	64	<1	<1	<1	<1
Nickel	mg/kg	42	42	188	360	1250	280	1300	**4.5**	<1	**1.3**	<1	38	270	**32.9**	**4.6**	**9.5**	**1.3**
Selenium	mg/kg	42	26	1.2	1.8	3.4	4	41	<1	<1	<1	<1	1	3	**6.5**	**1.1**	**3.5**	<1
Thallium	mg/kg	42	35	0.947	1.89	4.6	---	---	---	---	---	---	0.05	0.5	**92.0**	**9.2**	**37.8**	**3.8**
Vanadium	mg/kg	42	42	63	110	348	---	---	---	---	---	---	60	80	**5.8**	**4.4**	**1.8**	**1.4**
Zinc	mg/kg	42	42	216	342	871	120	930	**7.3**	<1	**2.9**	<1	160	810	**5.4**	**1.1**	**2.1**	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total LMW PAHs - 1/2MDL	mg/kg	41	40	459	2318	5561	18	---	**309**	---	**129**	---	---	---	---	---	---	---
Total LMW PAHs - MDL	mg/kg	41	40	461	2328	5594	18	---	**311**	---	**129**	---	---	---	---	---	---	---
Total LMW PAHs - Zero	mg/kg	41	40	458	2307	5529	18	---	**307**	---	**128**	---	---	---	---	---	---	---
Total HMW PAHs - 1/2MDL	mg/kg	41	41	1530	13433	22140	29	---	**763**	---	**463**	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	41	41	1530	9208	22140	29	---	**763**	---	**318**	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	41	41	1530	13433	22140	29	---	**763**	---	**463**	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Bis(2-Ethylhexyl) Phthalate	mg/kg	40	4	1.63	NC	5.9	---	---	---	---	---	---	---	---	---	---	---	---
Carbazole	mg/kg	40	38	12.9	53.7	190	---	---	---	---	---	---	---	---	---	---	---	---
Dibenzofuran	mg/kg	40	37	2.57	7.7	28	---	---	---	---	---	---	6.1	61	**4.6**	<1	**1.3**	<1
TCL Volatile Organic Compounds (TCL VOCs)																		
Cyclohexane	mg/kg	9	3	0.0048	NC	0.0086	---	---	---	---	---	---	---	---	---	---	---	---
Isopropylbenzene (Cumene)	mg/kg	9	2	0.0004	NC	0.00052	---	---	---	---	---	---	---	---	---	---	---	---
Methyl Acetate	mg/kg	9	5	0.0044	NC	0.0065	---	---	---	---	---	---	---	---	---	---	---	---
Methylcyclohexane	mg/kg	9	3	0.0086	NC	0.015	---	---	---	---	---	---	---	---	---	---	---	---
M,P-Xylene	mg/kg	9	5	0.0036	NC	0.0091	---	---	---	---	---	---	100	1000	<1	<1	---	---
O-Xylene (1,2-Dimethylbenzene)	mg/kg	9	3	0.0019	NC	0.0032	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{Inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{Inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-17
Sediment Direct Contact Exposure Estimate - North Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry												
Cyanide	mg/kg	22	22	12.52	41.15	137	0.1	1.0	**1370**	**137**	**412**	**41.2**
TAL Metals												
Antimony	mg/kg	22	7	1.5	0.9	2.6	---	---	---	---	---	---
Arsenic	mg/kg	22	22	10.6	13.55	26.4	10	33	**2.7**	<1	**1.4**	<1
Barium	mg/kg	22	22	197.4	245	539	150	300	**3.6**	**1.8**	**1.6**	<1
Beryllium	mg/kg	22	22	2.6	4.0	17	---	---	---	---	---	---
Cadmium	mg/kg	22	21	2.561	3.620	8.3	1	5	**8.4**	**1.7**	**3.7**	<1
Chromium, Total	mg/kg	24	24	24	29	53	43	110	**1.2**	<1	<1	<1
Copper	mg/kg	22	22	36	44	83.6	31	140	**2.7**	<1	**1.4**	<1
Lead	mg/kg	22	22	52.8	110.7	238	35	120	**6.8**	**2.0**	**3.2**	<1
Nickel	mg/kg	22	22	240.0	359.84	1250.0	22	48	**56.8**	**26.0**	**16.4**	**7.5**
Selenium	mg/kg	22	16	1.2	2	3	1	3	**4.7**	**1.2**	**2.5**	<1
Silver	mg/kg	22	2	1.0	0.0	1	1	5	**2.0**	<1	<1	<1
Thallium	mg/kg	22	19	0.854	1.891	4.6	---	---	---	---	---	---
Vanadium	mg/kg	22	22	77	110	348	---	---	---	---	---	---
Zinc	mg/kg	22	22	260	342	871	120	450	**7.3**	**1.9**	**2.9**	<1
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	30	30	11.0	NC	72.3	1.0	10	**72.3**	**7.2**	---	---
$ESBTU_{34}$	ESBTU	30	30	27.8	NC	199	1.0	10	**199**	**19.9**	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
Carbazole	mg/kg	22	21	16.2381	53.7367	190	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-18
Surface Water Direct Contact Exposure Estimate - North Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																									
Cyanide	U	µg/L	2	1	7.6	NC	7.6	5.2	22	**1.5**	<1	---	---	5.2	22	**1.5**	<1	---	---	5.2	22	**1.5**	<1	---	---
Fluoride	U	µg/L	2	2	12275	NC	22400	1800	4100	**12.4**	**5.5**	---	---	66500	380000	<1	<1	---	---	---	6000	---	**3.7**	---	---
Fluoride	F	µg/L	1	1	21500	NC	21500	1800	4100	**11.9**	**5.2**	---	---	66500	380000	<1	<1	---	---	---	6000	---	**3.6**	---	---
Metals																									
Aluminum	U	µg/L	2	2	4370	NC	8630	See Sample-Specific Evaluation in Table 6-19																	
Aluminum	F	µg/L	1	1	4780	NC	4780																		
Barium	U	µg/L	2	2	139	NC	234	3.9	39.0	**60.0**	**6.0**	---	---	3.9	39.0	**60.0**	**6.0**	---	---	3.9	39.0	**60.0**	**6.0**	---	---
Barium	F	µg/L	1	1	26	NC	26.4	3.9	39.0	**6.8**	<1	---	---	3.9	39.0	**6.8**	<1	---	---	3.9	39.0	**6.8**	<1	---	---
Beryllium	U	µg/L	2	1	1	NC	0.71	0.7	6.6	**1.1**	<1	---	---	0.7	6.6	**1.1**	<1	---	---	0.7	6.6	**1.1**	<1	---	---
Cadmium	U	µg/L	2	1	3	NC	3	See Sample-Specific Evaluation in Table 6-19																	
Cadmium	F	µg/L	1	1	3	NC	2.5																		
Copper	U	µg/L	2	2	10	NC	16.5	See Sample-Specific Evaluation in Table 6-19																	
Copper	F	µg/L	1	1	2	NC	2																		
Lead	U	µg/L	2	1	8	NC	7.6	See Sample-Specific Evaluation in Table 6-19																	
Nickel	U	µg/L	2	2	29	NC	55.9	See Sample-Specific Evaluation in Table 6-19																	
Vanadium	U	µg/L	2	2	12	NC	18	19.0	190.0	<1	<1	---	---	19.0	190.0	<1	<1	---	---	19.0	190.0	<1	<1	---	---
Zinc	U	µg/L	2	1	537	NC	537	See Sample-Specific Evaluation in Table 6-19																	
Zinc	F	µg/L	1	1	512	NC	512																		
Polycyclic Aromatic Hydrocarbons																									
Benzo(A)Anthracene	U	µg/L	1	1	3	NC	3	2.2	---	**1.3**	---	---	---	2.2	---	**1.3**	---	---	---	2.2	---	**1.3**	---	---	---
Benzo(A)Pyrene	U	µg/L	1	1	4	NC	3.9	1.0	---	**4.1**	---	---	---	1.0	---	**4.1**	---	---	---	1.0	---	**4.1**	---	---	---
Benzo(B)Fluoranthene	U	µg/L	1	1	10	NC	10	0.7	---	**14.8**	---	---	---	0.7	---	**14.8**	---	---	---	0.7	---	**14.8**	---	---	---
Benzo(G,H,I)Perylene	U	µg/L	1	1	4	NC	3.9	0.4	---	**8.9**	---	---	---	0.4	---	**8.9**	---	---	---	0.4	---	**8.9**	---	---	---
Chrysene	U	µg/L	1	1	8	NC	7.6	2.0	---	**3.7**	---	---	---	2.0	---	**3.7**	---	---	---	2.0	---	**3.7**	---	---	---
Fluoranthene	U	µg/L	1	1	9	NC	9.3	7.1	---	**1.3**	---	---	---	7.1	---	**1.3**	---	---	---	7.1	---	**1.3**	---	---	---
Indeno(1,2,3-C,D)Pyrene	U	µg/L	1	1	3	NC	3.1	0.3	---	**11.3**	---	---	---	0.3	---	**11.3**	---	---	---	0.3	---	**11.3**	---	---	---
Pyrene	U	µg/L	1	1	7	NC	7	10.1	---	<1	---	---	---	10.1	---	<1	---	---	---	10.1	---	<1	---	---	---

Notes:
µg/L, micrograms per liter
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
Fraction: U, Unfiltered; F, Filtered
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
UCL_{Mean}, Upper confidence limit of the mean concentration

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Table 6-19
Sample-Specific Surface Water Direct Contact Exposure Estimate - North Percolation Pond
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Filtered Aluminum					Unfiltered Aluminum					Filtered Cadmium					Unfiltered Cadmium				
			Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	$NOEC_{Plants}$	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-023-SW-04032017	CFSWP-023	4/3/2017						109	240	<1	450	<1						0.355 U	1.5	<1	4.2	<1
CFSWP-024-SW-06152017	CFSWP-024	6/15/2017	4780	87	**54.9**	750	**6.4**	8630	7.1	**1215**	11	**785**	2.5	0.4264	**5.9**	0.94	**2.7**	3	0.455	**6.6**	0.964	**3.1**

Sample ID	Station ID	Sampling Date	Filtered Copper					Unfiltered Copper					Unfiltered Lead					Unfiltered Nickel				
			Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-023-SW-04032017	CFSWP-023	4/3/2017						3.8	23.8		29.9		0.19 U	8.9		228		1.9	103	<1	928	<1
CFSWP-024-SW-06152017	CFSWP-024	6/15/2017	2	0.107	**18.6**	0.173	**11.6**	16.5	6.6	**2.5**	7.29	**2.3**	7.6	1.3	**5.8**	33.8	<1	55.9	29.0	**1.9**	261	<1

Sample ID	Station ID	Sampling Date	Filtered Zinc					Unfiltered Zinc				
			Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-023-SW-04032017	CFSWP-023	4/3/2017						3.5 U	237.3	<1	237	<1
CFSWP-024-SW-06152017	CFSWP-024	6/15/2017	512	65.7	**7.8**	65.1	**7.9**	537	66.6	**8.1**	66.6	**8.1**

Notes:
µg/L, micrograms per liter
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants

Table 6-20
Summary of Refined Wildlife Hazard Quotients for the North Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																		
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	1.57E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	1.69E+00	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	1.24E+00	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--
Lead	1.13E+00	--	2.95E+00	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	1.37E+00	--	4.90E+00	1.77E+00	--	--	--	--	--	--	1.31E+00	<1	--	--	--	--	--	--
Selenium	3.94E+00	1.39E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	1.44E+01	2.91E+00	4.28E+00	--	1.27E+00	--	<1	--	<1	--	<1	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Inorganics - Other Inorganics																		
Cyanide	3.45E+00	--	9.09E+00	--	--	--	<1	--	<1	--	--	--	--	--	--	--	--	--
Fluoride	2.17E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																		
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<1	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total LMW PAHs	1.20E+02	1.20E+01	5.45E+01	5.45E+00	1.13E+01	--	<1	--	--	--	1.55E+01	1.55E+00	--	--	--	--	--	--
Total HMW PAHs	2.84E+03	2.84E+02	1.03E+03	1.03E+02	2.68E+02	2.68E+01	1.57E+00	<1	<1	--	2.90E+02	2.90E+01	<1	--	<1	<1	4.32E+00	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																		
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																		
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																		
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	<1	--	--	--	--	--	--	--

EHS Support

Table 6-20
Summary of Refined Wildlife Hazard Quotients for the North Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals								
Aluminum	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	1.39E+00	--
Arsenic	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	3.50E+00	--
Chromium	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--
Nickel	1.11E+00	--	--	--	--	--	2.03E+01	2.33E+00
Selenium	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics								
Cyanide	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs								
Aroclor 1248	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbon								
Total LMW PAHs	--	--	--	--	--	--	5.10E+00	--
Total HMW PAHs	2.31E+02	3.69E+00	--	--	<1	--	1.44E+03	2.30E+01
Semi-volatile Organic Compound								
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	1.82E+00	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VO								
Methylcyclohexane	--	--	--	--	--	--	--	--
Dioxin/Furans								
Total Dioxins/Furans	--	--	--	--	--	--	--	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-21
Soil Direct Contact Exposure Estimate - South Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	38	33	1.243	4.429	16.4	---	---	---	---	---	---	6.4	---	**2.6**	---	<1	---
TAL Metals																		
Barium	mg/kg	38	38	430.963	640.099	972	330	3200	**2.9**	<1	**1.9**	<1	110	260	**8.8**	**3.7**	**5.8**	**2.5**
Cadmium	mg/kg	38	4	2	NC	2.5	140	760	<1	<1	---	---	32	160	<1	<1	---	---
Chromium, Total	mg/kg	38	38	9	11.363	32.8	3360	---	<1	---	<1	---	3360	---	<1	---	<1	---
Copper	mg/kg	38	38	81	203	694	80	530	**8.7**	**1.3**	**2.5**	<1	70	490	**9.9**	**1.4**	**2.9**	<1
Lead	mg/kg	38	38	15	34	116	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Mercury	mg/kg	38	32	0.13	0.35	1.4	0.05	0.5	**28.0**	**2.8**	**7.0**	<1	34	64	<1	<1	<1	<1
Nickel	mg/kg	38	38	14.413	18.965	53.9	280.0	1300	<1	<1	<1	<1	38	270	**1.4**	<1	<1	<1
Selenium		38	7	0.814	0.572	1.3												
Silver	mg/kg	38	3	10	NC	23.5	---	---	---	---	---	---	560	2800	<1	<1	---	---
Zinc	mg/kg	38	38	81.137	115.622	351	120	930	**2.9**	<1	<1	<1	160.0	810	**2.2**	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total HMW PAHs - 1/2MDL	mg/kg	38	35	3	5	19.6	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	38	35	3	5	20.2	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	38	35	3	4	19.1	29	---	<1	---	<1	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
4-Chloroaniline	mg/kg	38	4	0.7348	NC	1.9	1.8	18	**1.1**	<1	---	---	1.0	10	**1.9**	<1	---	---
Bis(2-Ethylhexyl) Phthalate	mg/kg	38	5	0.5960	NC	2.2	---	---	---	---	---	---	---	---	---	---	---	---
Di-N-Butyl Phthalate	mg/kg	38	6	0.0375	NC	0.058	---	---	---	---	---	---	160.0	600	<1	<1	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Cyclohexane	mg/kg	17	7	0.0018	NC	0.0046	---	---	---	---	---	---	---	---	---	---	---	---
Methyl Acetate	mg/kg	17	3	0.0071	NC	0.0089												
Methylcyclohexane	mg/kg	17	9	0.0023	NC	0.0081												
M,P-Xylene	mg/kg	17	11	0.0010	NC	0.0033	---	---	---	---	---	---	100	1000	<1	<1	---	---
O-Xylene (1,2-Dimethylbenzene)	mg/kg	17	7	0.0004	NC	0.0011	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-22
Sediment Direct Contact Exposure Estimate - South Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry												
Cyanide (Total)	mg/kg	26	22	1.72	4.43	16.4	0.1	1.0	**164.0**	**16.4**	**44.3**	**4.4**
Cyanide (Free)	mg/kg	2	1	0.89	NC	0.89	---	---	**---**	**---**	**---**	**---**
TAL Metals												
Barium	mg/kg	26	26	552	640	972	150	300	**6.5**	**3.2**	**4.3**	**2.1**
Cadmium	mg/kg	26	3	1.5	NC	2.5	1.0	4.9	**2.5**	<1	**---**	**---**
Copper	mg/kg	26	26	87.5	203	694	31	140	**22.4**	**5.0**	**6.5**	**1.4**
Lead	mg/kg	26	26	16.1	34.4	116	35	120	**3.3**	<1	<1	<1
Mercury	mg/kg	26	22	0.135	0.349	1.4	0.2	1.0	**7.8**	**1.4**	**1.9**	<1
Nickel	mg/kg	26	26	16	19	53.9	22	48	**2.5**	**1.1**	<1	<1
Silver	mg/kg	26	2	13	NC	23.5	0.5	5.0	**47.0**	**4.7**	**---**	**---**
Zinc	mg/kg	26	26	89	116	351	120	450	**2.9**	<1	<1	<1
Acid Volatile Sulfide-Simultaneously Extractable Metals												
(SEM-AVS)/fOC	μmol/g_{OC}	2	2	NC	NC	-24.4	130	1300	<1	<1	**---**	**---**
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	26	26	0.05	NC	0.18	1.0	10	<1	<1	**---**	**---**
$ESBTU_{34}$	ESBTU	26	26	0.14	NC	0.49	1.0	10	<1	<1	**---**	**---**
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
4-Chloroaniline	mg/kg	26	2	1.02	NC	1.9	---	---	**---**	**---**	**---**	**---**
Carbazole	mg/kg	26	18	0.11	0.24	0.97	---	---	**---**	**---**	**---**	**---**
Cyclohexane	mg/kg	5	2	0.00	NC	0.0046	---	---	**---**	**---**	**---**	**---**
Methylcyclohexane	mg/kg	5	2	0.0048	NC	0.0081	---	---	**---**	**---**	**---**	**---**

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-23
Pore Water Direct Contact Exposure Estimate - South Percolation Pond
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																									
Fluoride	F	µg/L	6	6	146	NC	269	1800	4100	<1	<1	---	---	66500	380000	<1	<1	---	---	---	6000	---	<1	---	---
TAL Metals																									
Aluminum	F	µg/L	6	2	107	NC	172	See Sample-Specific Evaluation in Table 6-24																	
Barium	F	µg/L	6	6	287	NC	421	3.9	39.0	**107.9**	**10.8**	---	---	3.9	39.0	**107.9**	**10.8**	---	---	3.9	39.0	**107.9**	**10.8**	---	---
Copper	F	µg/L	6	1	3	NC	2.9	See Sample-Specific Evaluation in Table 6-24																	
Iron	F	µg/L	6	5	178	NC	387	1000	10000	<1	<1	---	---	1000	10000	<1	<1	---	---	1000	10000	<1	<1	---	---
Manganese	F	µg/L	6	5	55	NC	169	1300	2300	<1	<1	---	---	1300	2300	<1	<1	---	---	1300	2300	<1	<1	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																									
Bis(2-Ethylhexyl) Phthalate	U	µg/L	6	1	0.12	NC	0.12	32.0	320	<1	<1	---	---	32.0	320	<1	<1	---	---	32.0	320	<1	<1	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{Inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{Inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-24
Sample-Specific Pore Water Direct Contact Exposure Estimate - South Percolation Pond
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Filtered Aluminum						Filtered Copper					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFPWP-018-PW-10172018	CFPWP-018	10/17/2018	172		87	**2.0**	750	<1	2.9		7.1	<1	11.4	<1
CFPWP-019-PW-10162018	CFPWP-019	10/16/2018	7.5	U	87	<1	750	<1	0.95	U	4.6	<1	7.4	<1
CFPWP-020-PW-10112018	CFPWP-020	10/11/2018	7.5	U	87	<1	750	<1	0.95	U	7.0	<1	11.3	<1
CFPWP-058-PW-10112018	CFPWP-058	10/11/2018	7.5	U	87	<1	750	<1	0.95	U	2.1	<1	3.3	<1
CFPWP-059-PW-10112018	CFPWP-059	10/11/2018	7.5	U	87	<1	750	<1	0.95	U	2.3	<1	3.6	<1
CFPWP-060-PW-10162018	CFPWP-060	10/16/2018	42.9		87	<1	750	<1	0.95	U	5.1	<1	8.3	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

EHS Support

Table 6-25
Surface Water Direct Contact Exposure Estimate - South Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																									
Cyanide (Total)	U	µg/L	20	12	29.9	52.88	139	5.2	22	**26.7**	**6.3**	**10.2**	**2.4**	5.2	22	**26.7**	**6.3**	**10.2**	**2.4**	5.2	22	**26.7**	**6.3**	**10.2**	**2.4**
Cyanide (Total)	F	µg/L	5	3	44.1	NC	68.2	5.2	22	**13.1**	**3.1**	---	---	5.2	22	**13.1**	**3.1**	---	---	5.2	22	**13.1**	**3.1**	---	---
Cyanide (Free)	U	µg/L	16	13	4.4	5.62	10	5.2	22	**1.9**	<1	**1.1**	<1	5.2	22	**1.9**	<1	**1.1**	<1	5.2	22	**1.9**	<1	**1.1**	<1
Metals																									
Aluminum	U	µg/L	26	22	1761	6018	24500	See Sample-Specific Evaluation in Table 6-26																	
Aluminum	F	µg/L	17	9	483	907	2360																		
Barium	U	µg/L	26	26	371	788	2710	3.9	39	**694.9**	**69.5**	**202.0**	**20.2**	3.9	39	**694.9**	**69.5**	**202.0**	**20.2**	3.9	39	**694.9**	**69.5**	**202.0**	**20.2**
Barium	F	µg/L	17	17	259	314	527	3.9	39	**135.1**	**13.5**	**80.4**	**8.0**	3.9	39	**135.1**	**13.5**	**80.4**	**8.0**	3.9	39	**135.1**	**13.5**	**80.4**	**8.0**
Copper	U	µg/L	26	19	20	47	183	See Sample-Specific Evaluation in Table 6-26																	
Copper	F	µg/L	17	7	8	13	33.4																		
Iron	U	µg/L	26	23	1606	5192	22500	1000	10000	**22.5**	**2.3**	**5.2**	<1	1000	10000	**22.5**	**2.3**	**5.2**	<1	1000	10000	**22.5**	**2.3**	**5.2**	<1
Iron	F	µg/L	17	10	354	640	1430	1000	10000	**1.4**	<1	<1	<1	1000	10000	**1.4**	<1	<1	<1	1000	10000	**1.4**	<1	<1	<1
Manganese	U	µg/L	26	23	41	89	337	1300	2300	<1	<1	<1	<1	1300	2300	<1	<1	<1	<1	1300	2300	<1	<1	<1	<1
Vanadium	U	µg/L	26	8	5	7	24.8	19	190	**1.3**	<1	<1	<1	19	190	**1.3**	<1	<1	<1	19	190	**1.3**	<1	<1	<1
Polycyclic Aromatic Hydrocarbons																									
Indeno(1,2,3-C,D)Pyrene	U	µg/L	5	1	0.28	NC	0.28	0.275	---	1.0	---	---	---	0.275	---	1.0	---	---	---	0.275	---	1.0	---	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
UCL_{Mean}, Upper confidence limit of the mean concentration

EHS Support

Table 6-26
Sample-Specific Surface Water Direct Contact Exposure Estimate - South Percolation Pond
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Filtered Aluminum						Unfiltered Aluminum						Filtered Copper						Unfiltered Copper					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)		NOEC	HQ_{NOEC}	$NOEC_{Plants}$	HQ_{LOEC}	Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-018-SW-04032017	CFSWP-018	4/3/2017							60.7		690	<1	2500	<1							1.9		20.1	<1	24.9	<1
CFSWP-018-SW-06062016	CFSWP-018	6/6/2016							6.75	U	710	<1	2600	<1							2		19.7	<1	24.4	<1
CFSWP-018-SW-06152017	CFSWP-018	6/15/2017	9.1	U	87	<1	750	<1	285		1100	<1	3800	<1	0.7	U	28.0	<1	45.1	<1	5.3		23.1	<1	28.9	<1
CFSWP-018-SW-06212018	CFSWP-018	6/21/2018	7.5	U	87	<1	750	<1	289		490	<1	1600	<1	1.9		2.9	<1	4.6	<1	5		23.3	<1	29.2	<1
CFSWP-018-SW-10172018	CFSWP-018	10/17/2018	288		87	**3.3**	750	<1	1240		1000	**1.2**	4300	<1	5.9		46.3	<1	74.5	<1	20.1		19.4	**1.0**	23.8	<1
CFSWP-018-SW-12012016	CFSWP-018	12/1/2016							583		800	<1	3000	<1							9.8		27.0	<1	34.4	<1
CFSWP-019-SW-04032017	CFSWP-019	4/3/2017							24.5		700	<1	2500	<1							1.8		19.7	<1	24.4	<1
CFSWP-019-SW-06062016	CFSWP-019	6/6/2016							18.7		820	<1	2900	<1							3.3		19.7	<1	24.4	<1
CFSWP-019-SW-06152017	CFSWP-019	6/15/2017	9.1	U	87	<1	750	<1	9.1	U	1300	<1	3800	<1	0.7	U	32.0	<1	51.6	<1	0.7	U	18.6	<1	22.8	<1
CFSWP-019-SW-06212018	CFSWP-019	6/21/2018	7.5	U	87	<1	750	<1	46.3		900	<1	2200	<1	0.95	U	5.6	<1	8.9	<1	0.95	U	18.9	<1	23.2	<1
CFSWP-019-SW-10162018	CFSWP-019	10/16/2018	198		87	**2.3**	750	<1	853		1000	<1	4400	<1	4.4		58.4	<1	94.0	<1	19.6		18.6	**1.1**	22.8	<1
CFSWP-019-SW-11072017	CFSWP-019	11/7/2017	2360		87	**27.1**	750	**3.1**	4330		940	**4.6**	3500	**1.2**	33.4		17.6	**1.9**	28.4	**1.2**	75.9		50.1	**1.5**	68.0	**1.1**
CFSWP-019-SW-12012016	CFSWP-019	12/1/2016							61.7		760	<1	2800	<1							1.6		22.3	<1	27.9	<1
CFSWP-020-SW-03162017	CFSWP-020	3/16/2017							9.1	U	85	<1	140	<1							0.7	U	17.9	<1	21.8	<1
CFSWP-020-SW-06062016	CFSWP-020	6/6/2016							15.3		890	<1	3000	<1							1.8		19.4	<1	23.8	<1
CFSWP-020-SW-06152017	CFSWP-020	6/15/2017	9.1	U	87	<1	750	<1	9.1	U	1100	<1	3500	<1	0.7	U	21.4	<1	34.5	<1	0.7	U	17.9	<1	21.8	<1
CFSWP-020-SW-06212018	CFSWP-020	6/21/2018	7.5	U	87	<1	750	<1	27.4		800	<1	1900	<1	0.95	U	3.6	<1	5.8	<1	0.95	U	17.4	<1	21.2	<1
CFSWP-020-SW-10112018	CFSWP-020	10/11/2018	326		87	**3.7**	750	<1	2310		1700	**1.4**	4000	<1	3.1		46.8	<1	75.4	<1	12.9		16.3	<1	19.7	<1
CFSWP-020-SW-11072017	CFSWP-020	11/7/2017	265		87	**3.0**	750	<1	24500		660	**37.1**	2100	**11.7**	3.6		5.0	<1	8.0	<1	183		137.2	**1.3**	206.5	<1
CFSWP-020-SW-12012016	CFSWP-020	12/1/2016							615		850	<1	3100	<1							4		26.7	<1	33.9	<1
CFSWP-058-SW-06212018	CFSWP-058	6/21/2018	7.5	U	87	<1	750	<1	75		1000	<1	2100	<1	0.95	U	4.7	<1	7.6	<1	0.95	U	17.8	<1	21.7	<1
CFSWP-058-SW-10112018	CFSWP-058	10/11/2018	752		87	**8.6**	750	**1.0**	1970		840	**2.3**	2500	<1	4.7		7.3	<1	11.7	<1	10.5		23.8	<1	29.9	<1
CFSWP-059-SW-06222018	CFSWP-059	6/22/2018	42.6		87	<1	750	<1	46.2		630	<1	1700	<1	0.95	U	3.5	<1	5.7	<1	0.95	U	17.8	<1	21.7	<1
CFSWP-059-SW-10112018	CFSWP-059	10/11/2018	54.1		87	<1	750	<1	689		1300	<1	2900	<1	0.95	U	11.0	<1	17.7	<1	7.7		20.5	<1	25.4	<1
CFSWP-060-SW-06222018	CFSWP-060	6/22/2018	7.5	U	87	<1	750	<1	497		870	<1	2100	<1	0.95	U	5.0	<1	8.1	<1	3.3		17.8	<1	21.7	<1
CFSWP-060-SW-10162018	CFSWP-060	10/16/2018	58.3		87	<1	750	<1	196		810	<1	2400	<1	0.95	U	7.0	<1	11.2	<1	1.9		17.1	<1	20.8	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

Table 6-27
Summary of Refined Wildlife Hazard Quotients for the South Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	4.11E+00	2.30E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	5.66E+00	--	<1	--	--	--	<1	--	--	--	<1	--	--	--	--	--
Lead	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	1.54E+00	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																
Cyanide	--	--	<1	--	--	--	<1	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<1	--
Polycyclic Aromatic Hydrocarbons (PAHs)																
Total LMW PAHs	--	--	--	--	--	--	<1	--	--	--	<1	--	--	--	--	--
Total HMW PAHs	1.45E+00	--	<1	<1	--	--	1.54E+00	<1	--	--	3.88E+00	<1	<1	--	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	2.59E+00	<1	--	--	--	--	--	--	2.79E+00	<1	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																
Total Dioxins/Furans	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--	--	--

Table 6-27
Summary of Refined Wildlife Hazard Quotients for the South Percolation Pond Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

	Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals										
Aluminum	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	2.25E+00	--
Chromium	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	2.43E+00	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	1.02E+00	--
Selenium	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics										
Cyanide	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCB										
Aroclor 1248	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbo										
Total LMW PAHs	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	--	--	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compoun										
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (V										
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans										
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--

EHS Support

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-28
Soil Direct Contact Exposure Estimate - Cedar Creek Reservoir Overflow Ditch
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	8	8	0.528	0.832	1.5	---	---	---	---	---	---	6.4	---	<1	---	<1	---
TAL Metals																		
Arsenic	mg/kg	8	8	5.900	6.828	7.8	6.8	68	**1.1**	<1	1.0	<1	18	91	<1	<1	<1	<1
Barium	mg/kg	8	8	240	274	295	330	3200	<1	<1	<1	<1	110	260	**2.7**	**1.1**	**2.5**	**1.1**
Copper	mg/kg	8	8	22.0	24.1	27.8	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	8	8	15	17	18.5	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Manganese	mg/kg	8	8	1070	1349	1640	450	4500	**3.6**	<1	**3.0**	<1	220	1100	**7.5**	**1.5**	**6.1**	**1.2**
Nickel	mg/kg	8	8	26	32	43.8	280	1300	<1	<1	<1	<1	38	270	**1.2**	<1	<1	<1
Selenium	mg/kg	8	6	0.645	0.788	1.4	4.1	41	<1	<1	<1	<1	0.5	3.0	**2.7**	<1	**1.5**	<1
Vanadium	mg/kg	8	8	13	15	18	---	---	---	---	---	---	60	80	<1	<1	<1	<1
Zinc	mg/kg	8	8	91.6	110	129	120	930	**1.1**	<1	<1	<1	160	810	<1	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																		
Total HMW PAHs - 1/2MDL	mg/kg	8	8	6.1	8.5	10.3	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - MDL	mg/kg	8	8	6.1	8.5	10.3	29	---	<1	---	<1	---	---	---	---	---	---	---
Total HMW PAHs - Zero	mg/kg	8	8	6.1	8.5	10.3	29	---	<1	---	<1	---	---	---	---	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Benzaldehyde	mg/kg	8	2	0.0625	NC	0.069	---	---	---	---	---	---	---	---	---	---	---	---
Bis(2-Ethylhexyl) Phthalate	mg/kg	8	1	0.0450	NC	0.045	---	---	---	---	---	---	---	---	---	---	---	---
Di-N-Butyl Phthalate	mg/kg	8	1	0.0390	NC	0.039	---	---	---	---	---	---	160	600	<1	<1	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-29
Sediment Direct Contact Exposure Estimate - Cedar Creek Reservoir Overflow Ditch
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry												
Cyanide	mg/kg	8	8	0.53	0.83	1.5	0.1	1.0	**15.0**	**1.5**	**8.3**	<1
TAL Metals												
Barium	mg/kg	8	8	240	274	295	150	300	**2.0**	<1	**1.8**	<1
Beryllium	mg/kg	8	8	0.746	0.87	1.0	---	---	---	---	---	---
Manganese	mg/kg	8	8	1070	1349	1640	460	1100	**3.6**	**1.5**	**2.9**	**1.2**
Nickel	mg/kg	8	8	26	32	43.8	22	48	**2.0**	<1	**1.5**	<1
Vanadium	mg/kg	8	8	13	15	18	---	---	---	---	---	---
Zinc	mg/kg	8	8	92	110	129	120	450	**1.1**	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	8	8	9.8	NC	77.1	1.0	10	**77.1**	**7.7**	---	---
$ESBTU_{34}$	ESBTU	8	8	26.8	NC	212	1.0	10	**212**	**21.2**	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
Acetophenone	mg/kg	8	1	0.01	NC	0.011	---	---	---	---	---	---
Benzaldehyde	mg/kg	8	2	0.06	NC	0.069	---	---	---	---	---	---
Carbazole	mg/kg	8	8	0.0948	NC	0.18	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-30
Surface Water Direct Contact Exposure Estimate - Cedar Creek Reservoir Overflow Ditch
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																									
Cyanide (Free)	U	µg/L	11	3	3.3	NC	5.8	5.2	22.0	**1.1**	<1	**---**	**---**	5.2	22.0	**1.1**	<1	**---**	**---**	5.2	22.0	**1.1**	<1	**---**	**---**
Metals																									
Aluminum	U	µg/L	27	20	134	369	1610	See Sample-Specific Evaluation in Table 6-31																	
Barium	U	µg/L	27	27	91	101	209	3.9	39.0	**53.6**	**5.4**	**26.0**	**2.6**	3.9	39.0	**53.6**	**5.4**	**26.0**	**2.6**	3.9	39.0	**53.6**	**5.4**	**26.0**	**2.6**
Barium	F	µg/L	16	16	91	106	218	3.9	39.0	**55.9**	**5.6**	**27.3**	**2.7**	3.9	39.0	**55.9**	**5.6**	**27.3**	**2.7**	3.9	39.0	**55.9**	**5.6**	**27.3**	**2.7**
Iron	U	µg/L	27	5	696	688	2910	1000	10000	**2.9**	<1	<1	<1	1000	10000	**2.9**	<1	<1	<1	1000	10000	**2.9**	<1	<1	<1
Manganese	U	µg/L	27	26	150	749	3750	1300	2300	**2.9**	**1.6**	<1	<1	1300	2300	**2.9**	**1.6**	<1	<1	1300	2300	**2.9**	**1.6**	<1	<1
Vanadium	U	µg/L	27	6	2	2	2.2	19.0	190	<1	<1	<1	<1	19.0	190	<1	<1	<1	<1	19.0	190	<1	<1	<1	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-31
Sample-Specific Surface Water Direct Contact Exposure Estimate - Cedar Creek Reservoir Overflow Ditch
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Station ID	Sampling Date	Sample ID	Unfiltered Aluminum					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-043	6/14/18	CFSWP-043-SW-06142018	7.5	U	630	<1	1700	<1
CFSWP-013	6/7/16	CFSWP-013-SW-06072016	30		940	<1	2200	<1
CFSWP-013	11/30/16	CFSWP-013-SW-11302016	1610		860	**1.9**	2100	<1
CFSWP-013	3/15/17	CFSWP-013-SW-03152017	38.6		47	<1	75	<1
CFSWP-013	6/12/17	CFSWP-013-SW-06122017	23.1		1400	<1	2300	<1
CFSWP-013	6/14/18	CFSWP-013-SW-06142018	7.5	U	840	<1	2000	<1
CFSWP-042	6/14/18	CFSWP-042-SW-06142018	7.5	U	670	<1	1800	<1
CFSWP-012	6/7/16	CFSWP-012-SW-06072016	35.9		1000	<1	2300	<1
CFSWP-012	4/3/17	CFSWP-012-SW-04032017	27.4		660	<1	1800	<1
CFSWP-012	6/12/17	CFSWP-012-SW-06122017	9.1	U	1500	<1	2300	<1
CFSWP-012	6/14/18	CFSWP-012-SW-06142018	23		640	<1	1700	<1
CFSWP-011	6/7/16	CFSWP-011-SW-06072016	28.2		1100	<1	2300	<1
CFSWP-011	4/3/17	CFSWP-011-SW-04032017	37.9		1100	<1	2400	<1
CFSWP-011	6/12/17	CFSWP-011-SW-06122017	9.1	U	1400	<1	2300	<1
CFSWP-011	6/14/18	CFSWP-011-SW-06142018	17.1		830	<1	2100	<1
CFSWP-041	6/14/18	CFSWP-041-SW-06142018	16.7		640	<1	1800	<1
CFSWP-010	6/7/16	CFSWP-010-SW-06072016	44.6		1200	<1	2400	<1
CFSWP-010	3/15/17	CFSWP-010-SW-03152017	507		49	**10.3**	78	**6.5**
CFSWP-010	6/12/17	CFSWP-010-SW-06122017	9.1	U	1500	<1	2400	<1
CFSWP-010	6/14/18	CFSWP-010-SW-06142018	50.6		620	<1	1700	<1
CFSWP-040	6/15/18	CFSWP-040-SW-06152018	24.5		620	<1	1700	<1
CFSWP-039	6/15/18	CFSWP-039-SW-06152018	22		270	<1	680	<1
CFSWP-039	10/11/18	CFSWP-039-SW-10112018	7.5	U	560	<1	1900	<1
CFSWP-009	6/7/16	CFSWP-009-SW-06072016	16.8		1100	<1	2400	<1
CFSWP-009	4/3/17	CFSWP-009-SW-04032017	34.8		920	<1	2200	<1
CFSWP-009	6/12/17	CFSWP-009-SW-06122017	64.4		990	<1	2300	<1
CFSWP-009	6/14/18	CFSWP-009-SW-06142018	18.7		280	<1	730	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

Table 6-32
Summary of Refined Wildlife Hazard Quotients for the Cedar Creek Reservoir Overflow Ditch
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals																
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	1.76E+00	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	1.10E+01	1.27E+00	--	--	<1	--	--	--	1.18E+01	1.37E+00	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	1.94E+00	--	--	--	--	--	<1	--	<1	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics																
Cyanide	--	--	--	--	--	--	<1	--	<1	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	2.00E+01	2.00E+00	--	--	--	--	--	--	2.51E+01	2.51E+00	--	--	<1	--
Polycyclic Aromatic Hydrocarbons (PAHs)																
Total LMW PAHs	--	--	--	--	--	--	<1	--	--	--	1.29E+00	--	--	--	--	--
Total HMW PAHs	2.26E+00	--	9.39E+00	<1	--	--	1.59E+00	<1	<1	--	1.40E+01	1.40E+00	<1	--	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	1.41E+00	--	--	--	--	--	--	--	2.39E+00	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																
Total Dioxins/Furans	--	--	<1	--	--	--	--	--	--	--	1.28E+00	--	--	--	--	--

Table 6-32
Summary of Refined Wildlife Hazard Quotients for the Cedar Creek Reservoir Overflow Ditch
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals										
Aluminum	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	2.01E+00	--
Selenium	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics										
Cyanide	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)										
Aroclor 1248	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)										
Total LMW PAHs	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	--	--	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH S										
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)										
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans										
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-33
Soil Direct Contact Exposure Estimate - Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Soil Invertebrate Communities						Terrestrial Plant Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																		
Cyanide	mg/kg	12	7	0.4	0.4	0.84	---	---	---	---	---	---	6.4	---	<1	---	<1	---
TAL Metals																		
Arsenic	mg/kg	12	12	7.38	9.33	14.5	7	68	**2.1**	<1	**1.4**	<1	18	91	<1	<1	<1	<1
Barium	mg/kg	12	12	448	586	905	330	3200	**2.7**	<1	**1.8**	<1	110	260	**8.2**	**3.5**	**5.3**	**2.3**
Copper	mg/kg	12	12	20	26	42.5	80	530	<1	<1	<1	<1	70	490	<1	<1	<1	<1
Lead	mg/kg	12	12	11.6	13.5	17.6	1700	8400	<1	<1	<1	<1	120	570	<1	<1	<1	<1
Manganese	mg/kg	12	12	317.6	480	988	450	4500	**2.2**	<1	**1.1**	<1	220	1100	**4.5**	<1	**2.2**	<1
Selenium	mg/kg	12	4	2.07	2	4.4	4	41	**1.1**	<1	<1	<1	1	3	**8.5**	**1.5**	**3.1**	<1
Vanadium	mg/kg	12	12	11.6	12.9	17.2	---	---	---	---	---	---	60	80	<1	<1	<1	<1
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																		
Benzaldehyde	mg/kg	12	2	0.07	NC	0.1	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HMW, High molecular weight
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
MDL, Method detection limit
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-34
Sediment Direct Contact Exposure Estimate - Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry												
Cyanide	mg/kg	12	7	0.41	0.41	0.84	0.1	1.0	**8.4**	<1	**4.1**	<1
TAL Metals												
Arsenic	mg/kg	12	12	7.4	9.3	14.5	10	33	**1.5**	<1	<1	<1
Barium	mg/kg	12	12	448	586	905.0	150	300	**6.0**	**3.0**	**3.9**	**2.0**
Beryllium	mg/kg	12	10	0.67	0.76	1.1	---	---	---	---	---	---
Copper	mg/kg	12	12	20.4	26.1	43	31	140	**1.4**	<1	<1	<1
Manganese	mg/kg	12	12	318	480	988	460	1100	**2.1**	<1	1.0	<1
Selenium	mg/kg	12	4	2	2	4.4	1	3	**6.1**	**1.5**	**2.2**	<1
Vanadium	mg/kg	12	12	12	13	17.2	---	---	---	---	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	12	12	0.012	NC	0.037	1.0	10	<1	<1	---	---
$ESBTU_{34}$	ESBTU	12	12	0.034	NC	0.102	1.0	10	<1	<1	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
Acetophenone	mg/kg	12	1	0.01	NC	0.0093	---	---	---	---	---	---
Benzaldehyde	mg/kg	12	2	0.07	NC	0.1	---	---	---	---	---	---
Carbazole	mg/kg	12	9	0.0127	0.0148	0.023	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-35
Pore Water Direct Contact Exposure Estimate - Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																									
Cyanide (Free)	F	µg/L	10	3	4	NC	8.3	5	22	**1.6**	<1	---	---	5	22	**1.6**	<1	---	---	5.2	22	**1.6**	<1	---	---
Fluoride	F	µg/L	10	10	209	NC	256	1800	4100	<1	<1	---	---	66500	380000	<1	<1	---	---	---	6000	---	<1	---	---
TAL Metals																									
Aluminum	F	µg/L	10	3	153	NC	337	See Sample-Specific Evaluation in Table 6-36																	
Barium	F	µg/L	10	10	146	NC	313	3.9	39.0	**80.3**	**8.0**	---	---	3.9	39.0	**80.3**	**8.0**	---	---	3.9	39.0	**80.3**	**8.0**	---	---
Iron	F	µg/L	10	6	189	NC	373	1000	10000	<1	<1	---	---	1000	10000	<1	<1	---	---	1000	10000	<1	<1	---	---
Manganese	F	µg/L	10	9	71	NC	345	1300	2300	<1	<1	---	---	1300	2300	<1	<1	---	---	1300	2300	<1	<1	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-36
Sample-Specific Pore Water Direct Contact Exposure Estimate - Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Filtered Aluminum					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFPWP-021-PW-06192018	CFPWP-021	6/19/2018	337		87	**3.9**	750	<1
CFPWP-022-PW-06202018	CFPWP-022	6/20/2018	7.5	U	87	<1	750	<1
CFPWP-046-PW-06192018	CFPWP-046	6/19/2018	7.5	U	87	<1	750	<1
CFPWP-047-PW-06192018	CFPWP-047	6/19/2018	7.5	U	87	<1	750	<1
CFPWP-048-PW-06202018	CFPWP-048	6/20/2018	7.5	U	87	<1	750	<1
CFPWP-049-PW-06202018	CFPWP-049	6/20/2018	7.5	U	87	<1	750	<1
CFPWP-050-PW-06212018	CFPWP-050	6/21/2018	83.7		87	<1	750	<1
CFPWP-051-PW-06212018	CFPWP-051	6/21/2018	7.5	U	87	<1	750	<1
CFPWP-052-PW-06182018	CFPWP-052	6/18/2018	37.4		87	<1	750	<1
CFPWP-053-PW-06182018	CFPWP-053	6/18/2018	7.5	U	87	<1	750	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

Table 6-37
Surface Water Direct Contact Exposure Estimate - Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Metals																									
Aluminum	U	μg/L	16	15	518	2713	5750	See Sample-Specific Evaluation in Table 6-38																	
Barium	U	μg/L	16	16	125	147	245	3.9	39.0	**62.8**	**6.3**	**37.6**	**3.8**	3.9	39.0	**62.8**	**6.3**	**37.6**	**3.8**	3.9	39.0	**62.8**	**6.3**	**37.6**	**3.8**
Barium	F	μg/L	11	11	121	147	229	3.9	39	**58.7**	**5.9**	**37.7**	**3.8**	3.9	39	**58.7**	**5.9**	**37.7**	**3.8**	3.9	39	**58.7**	**5.9**	**37.7**	**3.8**
Iron	U	μg/L	16	8	704	1696	4760	1000	10000	**4.8**	<1	**1.7**	<1	1000	10000	**4.8**	<1	**1.7**	<1	1000	10000	**4.8**	<1	**1.7**	<1
Manganese	U	μg/L	16	13	26	52	127	1300	2300	<1	<1	<1	<1	1300	2300	<1	<1	<1	<1	1300	2300	<1	<1	<1	<1
Vanadium	U	μg/L	16	3	3	NC	3.9	19.0	190	<1	<1	---	---	19.0	190	<1	<1	---	---	19.0	190	<1	<1	---	---

Notes:
μg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-38
Sample-Specific Surface Water Direct Contact Exposure Estimate - Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Unfiltered Aluminum					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-021-SW-06062016	CFSWP-021	6/6/2016	95.3		860	<1	2400	<1
CFSWP-021-SW-11302016	CFSWP-021	11/30/2016	5750		1500	**3.8**	3000	**1.9**
CFSWP-021-SW-03152017	CFSWP-021	3/15/2017	112		57	**2.0**	91	**1.2**
CFSWP-021-SW-06152017	CFSWP-021	6/15/2017	390		900	<1	3400	<1
CFSWP-021-SW-06192018	CFSWP-021	6/19/2018	36.5		310	<1	750	<1
CFSWP-022-SW-06062016	CFSWP-022	6/6/2016	937		810	**1.2**	2400	<1
CFSWP-022-SW-04032017	CFSWP-022	4/3/2017	140		550	<1	1800	<1
CFSWP-022-SW-06202018	CFSWP-022	6/20/2018	19		490	<1	1500	<1
CFSWP-046-SW-06192018	CFSWP-046	6/19/2018	45.8		620	<1	2300	<1
CFSWP-047-SW-06192018	CFSWP-047	6/19/2018	34.2		400	<1	1200	<1
CFSWP-048-SW-06202018	CFSWP-048	6/20/2018	16.1		300	<1	720	<1
CFSWP-049-SW-06202018	CFSWP-049	6/20/2018	17.1		590	<1	1900	<1
CFSWP-050-SW-06212018	CFSWP-050	6/21/2018	66.5		290	<1	600	<1
CFSWP-051-SW-06212018	CFSWP-051	6/21/2018	7.5	U	760	<1	2200	<1
CFSWP-052-SW-06182018	CFSWP-052	6/18/2018	59.2		730	<1	2800	<1
CFSWP-053-SW-06182018	CFSWP-053	6/18/2018	47.8		430	<1	1300	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

EHS Support

Table 6-39
Summary of Refined Wildlife Hazard Quotients for the Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	$NOEC_{Plants}$	HQ_{LOAEL}
Inorganics - Metals														
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	3.76E+00	2.11E+00	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	<1	--	--	<1	--	--	--	2.41E+00	<1	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	<1	<1	--	--
Selenium	3.49E+00	1.23E+00	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	1.69E+00	--	--	--	--	--	<1	--	<1	--	<1	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	--	--	--	--	--	--	<1	--	<1	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	<1	<1	--	--	--	--	--	--	5.02E+00	<1	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	--	--	--	--	--	--	<1	--	--	--	<1	--	--	--
Total HMW PAHs	--	--	<1	--	--	--	1.56E+00	<1	<1	--	4.54E+00	<1	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans	--	--	--	--	--	--	--	--	--	--				
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	<1	--	--	--

EHS Support

Table 6-39
Summary of Refined Wildlife Hazard Quotients for the Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	1.25E+00	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs)												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)												
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--

Table 6-39
Summary of Refined Wildlife Hazard Quotients for the Northern Surface Water Feature
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
$NOEC_{Plants}$, No Observed Effect Concentration, plants
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-40
Sediment Direct Contact Exposure Estimate - Flathead River
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry												
Cyanide	mg/kg	32	17	1.60	1.69	8.3	0.1	1.0	**83.0**	**8.3**	**16.9**	**1.7**
TAL Metals												
Barium	mg/kg	32	32	89.0	100.2	151	150.0	300.0	1.0	<1	<1	<1
Beryllium	mg/kg	32	31	0.4	0.42	0.6	---	---	---	---	---	---
Vanadium	mg/kg	32	32	14.3	15.6	25.5	---	---	---	---	---	---
Acid Volatile Sulfide-Simultaneously Extractable Metals												
(SEM-AVS)/fOC	µmol/g_{OC}	5	5	NC	NC	69.3	130.0	3000	<1	<1	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	32	32	0.66	NC	9.80	1.0	10	**9.8**	<1	---	---
$ESBTU_{34}$	ESBTU	32	32	1.70	NC	27.0	1.0	10	**27.0**	**2.7**	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
Benzaldehyde	mg/kg	27	2	0.0474	0.0000	0.085	---	---	---	---	---	---
Carbazole	mg/kg	27	6	0.1198	0.1062	0.36	---	---	---	---	---	---
TCL Volatile Organic Compounds (TCL VOCs)												
Cyclohexane	mg/kg	6	6	0.0025	0.0034	0.0039	---	---	---	---	---	---
Methyl Acetate	mg/kg	6	1	0.1100	0.0000	0.11	---	---	---	---	---	---
Methylcyclohexane	mg/kg	6	6	0.0049	0.0067	0.0085	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-41
Pore Water Direct Contact Exposure Estimate - Flathead River
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities						Aquatic Plant Communities						Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																									
Cyanide (Free)	F	µg/L	17	8	18	NC	62.4	5.2	22	**12.0**	**2.8**	---	---	5.2	22	**12.0**	**2.8**	---	---	5.2	22	**12.0**	**2.8**	---	---
Fluoride	F	µg/L	17	7	1604	NC	3140	1800	4100	**1.7**	<1	---	---	66500	380000	<1	<1	---	---	---	6000	---	<1	---	---
TAL Metals																									
Barium	F	µg/L	17	17	142	NC	261	3.9	39.0	**66.9**	**6.7**	---	---	3.9	39.0	**66.9**	**6.7**	---	---	3.9	39.0	**66.9**	**6.7**	---	---
Iron	F	µg/L	17	5	142	NC	172	1000	10000	<1	<1	---	---	1000	10000	<1	<1	---	---	1000	10000	<1	<1	---	---
Manganese	F	µg/L	17	6	148	NC	509	1300	2300	<1	<1	---	---	1300	2300	<1	<1	---	---	1300	2300	<1	<1	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																									
Acetophenone	U	µg/L	17	1	0.190	NC	0.19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bis(2-Ethylhexyl) Phthalate	U	µg/L	17	12	11.458	NC	26	32.0	320	<1	<1	---	---	32.0	320	<1	<1	---	---	32.0	320	<1	<1	---	---
Caprolactam	U	µg/L	17	12	1.458	NC	2.7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Carbazole	U	µg/L	17	1	0.130	NC	0.13	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-42
Surface Water Direct Contact Exposure Estimate - Flathead River
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Communities					
										Maximum EPC		Refined EPC				Maximum EPC		Refined EPC				Maximum EPC		Refined EPC	
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}	$NOEC_{Plants}$	$LOEC_{Plants}$	HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}	$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																									
Cyanide (Total)	U	µg/L	59	22	96	62	327	5.2	22	**62.9**	**14.9**	**11.9**	**2.8**	5.2	22	**62.9**	**14.9**	**11.9**	**2.8**	5.2	22	**62.9**	**14.9**	**11.9**	**2.8**
Cyanide (Total)	F	µg/L	15	9	109	183	328	5.2	22	**63.1**	**14.9**	**35.2**	**8.3**	5.2	22	**63.1**	**14.9**	**35.2**	**8.3**	5.2	22	**63.1**	**14.9**	**35.2**	**8.3**
Cyanide (Free)	U	µg/L	48	26	19	26.8	139	5.2	22	**26.7**	**6.3**	**5.2**	**1.2**	5.2	22	**26.7**	**6.3**	**5.2**	**1.2**	5.2	22	**26.7**	**6.3**	**5.2**	**1.2**
Cyanide (Free)	F	µg/L	10	10	10	23.2	42.2	5.2	22	**8.1**	**1.9**	**4.5**	**1.1**	5.2	22	**8.1**	**1.9**	**4.5**	**1.1**	5.2	22	**8.1**	**1.9**	**4.5**	**1.1**
TAL Metals																									
Aluminum	U	µg/L	76	70	333	486	1540	See Sample-Specific Evaluation in Table 6-43																	
Barium	U	µg/L	76	76	110	117	216	3.9	39	**55.4**	**5.5**	**30.0**	**3.0**	3.9	39	**55.4**	**5.5**	**30.0**	**3.0**	3.9	39	**55.4**	**5.5**	**30.0**	**3.0**
Barium	F	µg/L	49	49	95	104	191	3.9	39	**49.0**	**4.9**	**26.6**	**2.7**	3.9	39	**49.0**	**4.9**	**26.6**	**2.7**	3.9	39	**49.0**	**4.9**	**26.6**	**2.7**
Iron	U	µg/L	76	51	552	477	1640	1000	10000	**1.6**	<1	<1	<1	1000	10000	**1.6**	<1	<1	<1	1000	10000	**1.6**	<1	<1	<1
Iron	F	µg/L	49	11	99	63	164	1000	10000	<1	<1	<1	<1	1000	10000	<1	<1	<1	<1	1000	10000	<1	<1	<1	<1
Manganese	U	µg/L	76	54	29	28	212	1300	2300	<1	<1	<1	<1	1300	2300	<1	<1	<1	<1	1300	2300	<1	<1	<1	<1
Vanadium	U	µg/L	76	4	1	1	1.9	19	190	<1	<1	<1	<1	19	190	<1	<1	<1	<1	19	190	<1	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																									
Benzo(B)Fluoranthene	U	µg/L	11	3	0.269	NC	0.7	0.7	---	1.0	**---**	**---**	**---**	0.7	---	1.0	**---**	**---**	**---**	0.7	---	1.0	**---**	**---**	**---**
Pyrene	U	µg/L	11	4	0.453	NC	1.6	10.1	---	<1	**---**	**---**	**---**	10.1	---	<1	**---**	**---**	**---**	10.1	---	<1	**---**	**---**	**---**
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																									
Bis(2-Ethylhexyl) Phthalate	U	µg/L	11	4	9	8	22	32.0	320	<1	<1	<1	<1	32.0	320	<1	<1	<1	<1	32.0	320	<1	<1	<1	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-43
Sample-Specific Surface Water Direct Contact Exposure Estimate - Flathead River
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Unfiltered Aluminum					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-001-SW-09162016	CFSWP-001	9/16/2016	23.7		850	<1	1800	<1
CFSWP-001-SW-12022016	CFSWP-001	12/2/2016	25.6		1100	<1	2100	<1
CFSWP-001-SW-04042017	CFSWP-001	4/4/2017	103		430	<1	1100	<1
CFSWP-001-SW-06142017	CFSWP-001	6/14/2017	824		600	**1.4**	1400	<1
CFSWP-001-SW-06072018	CFSWP-001	6/7/2018	383		70	**5.5**	110	**3.5**
CFSWP-001-SW-10052018	CFSWP-001	10/5/2018	925		950	<1	2000	<1
CFSWP-002-SW-09162016	CFSWP-002	9/16/2016	28.8		830	<1	1800	<1
CFSWP-002-SW-12022016	CFSWP-002	12/2/2016	23.7		1200	<1	2100	<1
CFSWP-002-SW-04042017	CFSWP-002	4/4/2017	139		510	<1	1300	<1
CFSWP-002-SW-06142017	CFSWP-002	6/14/2017	9.1	U	1300	<1	2100	<1
CFSWP-002-SW-06072018	CFSWP-002	6/7/2018	324		200	**1.6**	440	<1
CFSWP-002-SW-10052018	CFSWP-002	10/5/2018	27.2		1000	<1	2000	<1
CFSWP-003-SW-09092016	CFSWP-003	9/9/2016	63.5		200	<1	440	<1
CFSWP-003-SW-12012016	CFSWP-003	12/1/2016	172		920	<1	2000	<1
CFSWP-003-SW-03162017	CFSWP-003	3/16/2017	794		54	**14.7**	87	**9.1**
CFSWP-003-SW-06142017	CFSWP-003	6/14/2017	746		1300	<1	2000	<1
CFSWP-003-SW-10312017	CFSWP-003	10/31/2017	800		850	<1	2000	<1
CFSWP-003-SW-06062018	CFSWP-003	6/6/2018	279		110	**2.5**	170	**1.6**
CFSWP-003-SW-10042018	CFSWP-003	10/4/2018	233		420	<1	1200	<1
CFSWP-004-SW-09092016	CFSWP-004	9/9/2016	522		380	**1.4**	1200	<1
CFSWP-004-SW-12012016	CFSWP-004	12/1/2016	53.3		700	<1	1900	<1
CFSWP-004-SW-03162017	CFSWP-004	3/16/2017	625		51	**12.3**	82	**7.6**
CFSWP-004-SW-06142017	CFSWP-004	6/14/2017	619		1400	<1	2200	<1
CFSWP-004-SW-10312017	CFSWP-004	10/31/2017	1180		790	**1.5**	2100	<1
CFSWP-004-SW-06062018	CFSWP-004	6/6/2018	139		230	<1	520	<1
CFSWP-004-SW-10042018	CFSWP-004	10/4/2018	861		430	**2.0**	1400	<1
CFSWP-005-SW-09092016	CFSWP-005	9/9/2016	143		380	<1	1200	<1
CFSWP-005-SW-12012016	CFSWP-005	12/1/2016	94.3		690	<1	2000	<1
CFSWP-005-SW-03162017	CFSWP-005	3/16/2017	521		51	**10.2**	81	**6.4**
CFSWP-005-SW-06142017	CFSWP-005	6/14/2017	553		1000	<1	2200	<1
CFSWP-005-SW-11012017	CFSWP-005	11/1/2017	33.9		480	<1	1500	<1
CFSWP-005-SW-06062018	CFSWP-005	6/6/2018	221		340	<1	900	<1
CFSWP-005-SW-10182018	CFSWP-005	10/18/2018	7.5	U	520	<1	1700	<1
CFSWP-006-SW-09092016	CFSWP-006	9/9/2016	19.9		690	<1	1600	<1
CFSWP-006-SW-12012016	CFSWP-006	12/1/2016	29.8		1400	<1	2300	<1
CFSWP-006-SW-03162017	CFSWP-006	3/16/2017	1540		54	**28.5**	87	**17.7**
CFSWP-006-SW-06142017	CFSWP-006	6/14/2017	1000		1300	<1	2000	<1
CFSWP-006-SW-06062018	CFSWP-006	6/6/2018	398		560	<1	1300	<1
CFSWP-006-SW-10042018	CFSWP-006	10/4/2018	53.9		160	<1	280	<1
CFSWP-007-SW-09162016	CFSWP-007	9/16/2016	28.9		640	<1	1500	<1
CFSWP-007-SW-12022016	CFSWP-007	12/2/2016	54.5		1200	<1	2100	<1
CFSWP-007-SW-03162017	CFSWP-007	3/16/2017	1460		55	**26.5**	89	**16.4**
CFSWP-007-SW-06142017	CFSWP-007	6/14/2017	879		1300	<1	1900	<1
CFSWP-007-SW-06072018	CFSWP-007	6/7/2018	647		370	**1.7**	930	<1
CFSWP-007-SW-10032018	CFSWP-007	10/3/2018	22.9		400	<1	1100	<1
CFSWP-008-SW-09162016	CFSWP-008	9/16/2016	33.9		540	<1	1400	<1
CFSWP-008-SW-12022016	CFSWP-008	12/2/2016	31		1200	<1	2100	<1
CFSWP-008-SW-04042017	CFSWP-008	4/4/2017	133		450	<1	1200	<1
CFSWP-008-SW-06142017	CFSWP-008	6/14/2017	9.1	U	1100	<1	2000	<1
CFSWP-008-SW-06072018	CFSWP-008	6/7/2018	454		450	**1.0**	1100	<1
CFSWP-008-SW-10032018	CFSWP-008	10/3/2018	7.5	U	320	<1	830	<1
CFSWP-017-SW-09162016	CFSWP-017	9/16/2016	33.2		540	<1	1500	<1
CFSWP-017-SW-12022016	CFSWP-017	12/2/2016	26.3		830	<1	1800	<1
CFSWP-017-SW-04042017	CFSWP-017	4/4/2017	138		54	**2.6**	87	**1.6**

Table 6-43
Sample-Specific Surface Water Direct Contact Exposure Estimate - Flathead River
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Unfiltered Aluminum					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-017-SW-06142017	CFSWP-017	6/14/2017	26.6		1300	<1	2000	<1
CFSWP-017-SW-06072018	CFSWP-017	6/7/2018	436		540	<1	1300	<1
CFSWP-017-SW-10032018	CFSWP-017	10/3/2018	38.5		240	<1	570	<1
CFSWP-026-SW-10312017	CFSWP-026	10/31/2017	41.1		490	<1	1300	<1
CFSWP-026-SW-06072018	CFSWP-026	6/7/2018	395		370	**1.1**	960	<1
CFSWP-026-SW-10052018	CFSWP-026	10/5/2018	232		320	<1	850	<1
CFSWP-027-SW-10312017	CFSWP-027	10/31/2017	154		720	<1	1700	<1
CFSWP-027-SW-06062018	CFSWP-027	6/6/2018	410		400	**1.0**	1000	<1
CFSWP-027-SW-10052018	CFSWP-027	10/5/2018	59.5		290	<1	740	<1
CFSWP-028-SW-10312017	CFSWP-028	10/31/2017	617		1000	<1	2100	<1
CFSWP-028-SW-06062018	CFSWP-028	6/6/2018	410		330	**1.2**	830	<1
CFSWP-028-SW-10042018	CFSWP-028	10/4/2018	7.5	U	490	<1	1400	<1
CFSWP-034-SW-06072018	CFSWP-034	6/7/2018	363		200	**1.8**	410	<1
CFSWP-034-SW-10052018	CFSWP-034	10/5/2018	23		1100	<1	2000	<1
CFSWP-035-SW-06072018	CFSWP-035	6/7/2018	331		300	**1.1**	760	<1
CFSWP-035-SW-10052018	CFSWP-035	10/5/2018	31.2		890	<1	2000	<1
CFSWP-036-SW-06062018	CFSWP-036	6/6/2018	539		440	**1.2**	1100	<1
CFSWP-036-SW-10042018	CFSWP-036	10/4/2018	39.8		390	<1	1000	<1
CFSWP-037-SW-06062018	CFSWP-037	6/6/2018	349		440	<1	1000	<1
CFSWP-037-SW-10032018	CFSWP-037	10/3/2018	17.5		480	<1	1200	<1
CFSWP-038-SW-06072018	CFSWP-038	6/7/2018	359		460	<1	1100	<1
CFSWP-038-SW-10032018	CFSWP-038	10/3/2018	7.5	U	410	<1	1100	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

Table 6-44
Sediment Direct Contact Exposure Estimate - Flathead River Outside the Backwater Seep Sampling Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
TAL Metals												
Barium	mg/kg	15	15	68.1	NC	146	150	300	<1	<1	---	---
Beryllium	mg/kg	15	14	0.4	NC	0.5	---	---	---	---	---	---
Vanadium	mg/kg	15	15	15.0	NC	25.5	---	---	---	---	---	---
Acid Volatile Sulfide-Simultaneously Extractable Metals												
(SEM-AVS)/fOC	µmol/g_{OC}	1	1	NC	NC	26.6	130	3000	<1	<1	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	15	15	0.70	NC	9.80	1.0	10	**9.8**	<1	---	---
$ESBTU_{34}$	ESBTU	16	16	1.80	NC	27.0	1.0	10	**27.0**	**2.7**	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
Benzaldehyde	mg/kg	14	1	0.0098	NC	0.0098	---	---	---	---	---	---
Carbazole	mg/kg	14	3	0.0183	NC	0.048	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-45
Pore Water Direct Contact Exposure Estimate - Flathead River Outside the Backwater Seep Sampling Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities						Aquatic Plant Communities						Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
TAL Metals																									
Barium	F	µg/L	10	10	135	NC	261	3.9	39.0	**66.9**	**6.7**	---	---	3.9	39.0	**66.9**	**6.7**	---	---	3.9	39.0	**66.9**	**6.7**	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																									
Acetophenone	U	µg/L	10	1	0.190	NC	0.19	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bis(2-Ethylhexyl) Phthalate	U	µg/L	10	7	10.214	NC	15	32.0	320	<1	<1	---	---	32.0	320	<1	<1	---	---	32.0	320	<1	<1	---	---
Caprolactam	U	µg/L	10	6	1.455	NC	2.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-46
Surface Water Direct Contact Exposure Estimate - Flathead River Outside the Backwater Seep Sampling Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
TAL Metals																									
Aluminum	U	µg/L	40	36	18	324	1540	See Sample-Specific Evaluation in Table 6-47																	
Barium	U	µg/L	40	40	63	94	139	3.9	39	**35.6**	**3.6**	**24.2**	**2.4**	3.9	39	**35.6**	**3.6**	**24.2**	**2.4**	3.9	39	**35.6**	**3.6**	**24.2**	**2.4**
Barium	F	µg/L	25	25	64	81	139	3.9	39	**35.6**	**3.6**	**20.7**	**2.1**	3.9	39	**35.6**	**3.6**	**20.7**	**2.1**	3.9	39	**35.6**	**3.6**	**20.7**	**2.1**
Iron	U	µg/L	40	19	127	685	1640	1000	10000	**1.6**	<1	<1	<1	1000	10000	**1.6**	<1	<1	<1	1000	10000	**1.6**	<1	<1	<1
Vanadium	U	µg/L	40	3	1	2	1.9	19	190	<1	<1	<1	<1	19	190	<1	<1	<1	<1	19	190	<1	<1	<1	<1
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																									
Bis(2-Ethylhexyl) Phthalate	U	µg/L	1	1	22	22	22	32.0	320	<1	<1	<1	<1	32.0	320	<1	<1	<1	<1	32.0	320	<1	<1	<1	<1
Caprolactam	U	µg/L	1	1	1	1	1.1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-47
Sample-Specific Surface Water Direct Contact Exposure Estimate - Flathead River Outside the Backwater Seep Sampling Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Unfiltered Aluminum					
			Result (µg/L)		NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-001-SW-04042017	CFSWP-001	4/4/2017	103		430	<1	1100	<1
CFSWP-001-SW-06072018	CFSWP-001	6/7/2018	383		70	**5.5**	110	**3.5**
CFSWP-001-SW-06142017	CFSWP-001	6/14/2017	824		600	**1.4**	1400	<1
CFSWP-001-SW-09162016	CFSWP-001	9/16/2016	23.7		850	<1	1800	<1
CFSWP-001-SW-10052018	CFSWP-001	10/5/2018	925		950	<1	2000	<1
CFSWP-001-SW-12022016	CFSWP-001	12/2/2016	25.6		1100	<1	2100	<1
CFSWP-002-SW-04042017	CFSWP-002	4/4/2017	139		510	<1	1300	<1
CFSWP-002-SW-06072018	CFSWP-002	6/7/2018	324		200	**1.6**	440	<1
CFSWP-002-SW-06142017	CFSWP-002	6/14/2017	9.1	U	1300	<1	2100	<1
CFSWP-002-SW-09162016	CFSWP-002	9/16/2016	28.8		830	<1	1800	<1
CFSWP-002-SW-10052018	CFSWP-002	10/5/2018	27.2		1000	<1	2000	<1
CFSWP-002-SW-12022016	CFSWP-002	12/2/2016	23.7		1200	<1	2100	<1
CFSWP-006-SW-03162017	CFSWP-006	3/16/2017	1540		54	**28.5**	87	**17.7**
CFSWP-006-SW-06062018	CFSWP-006	6/6/2018	398		560	<1	1300	<1
CFSWP-006-SW-06142017	CFSWP-006	6/14/2017	1000		1300	<1	2000	<1
CFSWP-006-SW-09092016	CFSWP-006	9/9/2016	19.9		690	<1	1600	<1
CFSWP-006-SW-10042018	CFSWP-006	10/4/2018	53.9		160	<1	280	<1
CFSWP-006-SW-12012016	CFSWP-006	12/1/2016	29.8		1400	<1	2300	<1
CFSWP-007-SW-03162017	CFSWP-007	3/16/2017	1460		55	**26.5**	89	**16.4**
CFSWP-007-SW-06072018	CFSWP-007	6/7/2018	647		370	**1.7**	930	<1
CFSWP-007-SW-06142017	CFSWP-007	6/14/2017	879		1300	<1	1900	<1
CFSWP-007-SW-09162016	CFSWP-007	9/16/2016	28.9		640	<1	1500	<1
CFSWP-007-SW-10032018	CFSWP-007	10/3/2018	22.9		400	<1	1100	<1
CFSWP-007-SW-12022016	CFSWP-007	12/2/2016	54.5		1200	<1	2100	<1
CFSWP-008-SW-04042017	CFSWP-008	4/4/2017	133		450	<1	1200	<1
CFSWP-008-SW-06072018	CFSWP-008	6/7/2018	454		450	**1.0**	1100	<1
CFSWP-008-SW-06142017	CFSWP-008	6/14/2017	9.1	U	1100	<1	2000	<1
CFSWP-008-SW-09162016	CFSWP-008	9/16/2016	33.9		540	<1	1400	<1
CFSWP-008-SW-10032018	CFSWP-008	10/3/2018	7.5	U	320	<1	830	<1
CFSWP-008-SW-12022016	CFSWP-008	12/2/2016	31		1200	<1	2100	<1
CFSWP-034-SW-06072018	CFSWP-034	6/7/2018	363		200	**1.8**	410	<1
CFSWP-034-SW-10052018	CFSWP-034	10/5/2018	23		1100	<1	2000	<1
CFSWP-035-SW-06072018	CFSWP-035	6/7/2018	331		300	**1.1**	760	<1
CFSWP-035-SW-10052018	CFSWP-035	10/5/2018	31.2		890	<1	2000	<1
CFSWP-036-SW-06062018	CFSWP-036	6/6/2018	539		440	**1.2**	1100	<1
CFSWP-036-SW-10042018	CFSWP-036	10/4/2018	39.8		390	<1	1000	<1
CFSWP-037-SW-06062018	CFSWP-037	6/6/2018	349		440	<1	1000	<1
CFSWP-037-SW-10032018	CFSWP-037	10/3/2018	17.5		480	<1	1200	<1
CFSWP-038-SW-06072018	CFSWP-038	6/7/2018	359		460	<1	1100	<1
CFSWP-038-SW-10032018	CFSWP-038	10/3/2018	7.5	U	410	<1	1100	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

Table 6-48
Summary of Refined Wildlife Hazard Quotients for the Flathead River
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	American Dipper		Belted Kingfisher		Mink	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals						
Aluminum	--	--	--	--	--	--
Antimony	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--
Barium	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--
Chromium	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--
Copper	--	--	--	--	--	--
Lead	--	--	--	--	--	--
Manganese	--	--	--	--	--	--
Mercury	--	--	--	--	--	--
Nickel	--	--	--	--	--	--
Selenium	--	--	--	--	--	--
Silver	--	--	--	--	--	--
Thallium	--	--	--	--	--	--
Vanadium	2.03E+00	--	1.46E+00	--	--	--
Zinc	--	--	--	--	--	--
Inorganics - Other Inorganics						
Cyanide	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)						
Aroclor 1248	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)						
Total LMW PAHs	--	--	--	--	--	--
Total HMW PAHs	1.41E+00	--	1.60E+00	--	1.46E+00	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs						
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)						
Methylcyclohexane	--	--	--	--	--	--
Dioxin/Furans						
Total Dioxins/Furans	--	--	--	--	--	--

Notes:

--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
Dark shaded cells for threatened or endangered species indicate that conclusions for that species are only based upon HQ_{NOAEL} values.

HMW, High molecular weight

HQ, Hazard quotient

$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.

$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.

LMW, Low molecular weight

PAH, Polycyclic Aromatic Hydrocarbon

PCB, Polychlorinated Biphenyl

SVOC, Semi-Volatile Organic Compound

VOC, Volatile Organic Compound

Table 6-49
Sediment Direct Contact Exposure Estimate - Flathead Riparian Area Channel
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry												
Cyanide	mg/kg	10	10	0.82	1.05	1.7	0.1	1.0	**17.0**	**1.7**	**10.5**	**1.1**
TAL Metals												
Barium	mg/kg	10	10	135.7	160.9	208	150	300	**1.4**	<1	**1.1**	<1
Beryllium	mg/kg	10	10	0.5	0.57	0.7	---	---	---	---	---	---
Thallium	mg/kg	10	1	0.2	NC	0.18	---	---	---	---	---	---
Vanadium	mg/kg	10	10	16.3	18.6	24.2	---	---	---	---	---	---
Acid Volatile Sulfide-Simultaneously Extractable Metals												
(SEM-AVS)/fOC	µmol/g_{OC}	4	4	NC	NC	43.7	130	1300	<1	<1	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	10	10	0.19	NC	1.45	1.0	10	**1.5**	<1	---	---
$ESBTU_{34}$	ESBTU	10	10	0.49	NC	3.99	1.0	10	**4.0**	<1	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
Acetophenone	mg/kg	9	1	0.0085	0.0000	0.0085	---	---	---	---	---	---
Benzaldehyde	mg/kg	9	3	0.0417	0.0000	0.062	---	---	---	---	---	---
Carbazole	mg/kg	9	5	0.0255	0.0319	0.07	---	---	---	---	---	---
TCL Volatile Organic Compounds (TCL VOCs)												
Cyclohexane	mg/kg	5	5	0.0023	0.0031	0.0032	---	---	---	---	---	---
Methylcyclohexane	mg/kg	5	5	0.0042	0.0054	0.006	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-50
Pore Water Direct Contact Exposure Estimate - Flathead Riparian Area Channel
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry													
Cyanide	F	µg/L	5	5	238	NC	429	5.2	22	**82.5**	**19.5**	---	---
Cyanide (Free)	F	µg/L	5	5	20	NC	38.7	5.2	22	**7.4**	**1.8**	---	---
Fluoride	F	µg/L	5	5	2002	NC	2410	1800	4100	**1.3**	<1	---	---
TAL Metals													
Arsenic	F	µg/L	5	3	1.97	NC	3.9	150	340	<1	<1	---	---
Barium	F	µg/L	5	5	288	NC	394	3.9	39.0	**101**	**10.1**	---	---
Iron	F	µg/L	5	5	2111	NC	6910	1000	10000	**6.9**	<1	---	---
Manganese	F	µg/L	5	4	213	NC	527	1300	2300	<1	<1	---	---
Polycyclic Aromatic Hydrocarbons (PAHs)													
Benzo(A)Anthracene	U	µg/L	5	1	0.081	NC	0.081	2.2	---	<1	---	---	---
Benzo(A)Pyrene	U	µg/L	5	1	0.058	NC	0.058	1.0	---	<1	---	---	---
Benzo(G,H,I)Perylene	U	µg/L	5	1	0.093	NC	0.093	0.4	---	<1	---	---	---
Chrysene	U	µg/L	5	1	0.085	NC	0.085	2.0	---	<1	---	---	---
Dibenz(A,H)Anthracene	U	µg/L	5	1	0.140	NC	0.14	0.3	---	<1	---	---	---
Fluoranthene	U	µg/L	5	1	0.084	NC	0.084	7.1	---	<1	---	---	---
Indeno(1,2,3-C,D)Pyrene	U	µg/L	5	1	0.091	NC	0.091	0.3	---	<1	---	---	---
Pyrene	U	µg/L	5	1	0.071	NC	0.071	10.1	---	<1	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)													
Caprolactam	U	µg/L	5	3	0.603	NC	0.62	---	---	---	---	---	---
Carbazole	U	µg/L	5	1	0.074	NC	0.074	---	---	---	---	---	---

Constituent	Aquatic Plant Communities								Amphibian Communities				
	$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/}$ Amphibians	$LOEC_{Fish/}$ Amphibians	Maximum EPC		Refine		
			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}		
Inorganic Chemistry													
Cyanide	5.2	22	**82.5**	**19.5**	---	---	5.2	22	**82.5**	**19.5**	---		
Cyanide (Free)	5.2	22	**7.4**	**1.8**	---	---	5.2	22	**7.4**	**1.8**	---		
Fluoride	66500	380000	<1	<1	---	---	---	6000	---	<1	---		
TAL Metals													
Arsenic	150	340	<1	<1	---	---	150	340	<1	<1	---		
Barium	3.9	39.0	**101.0**	**10.1**	---	---	3.9	39.0	**101.0**	**10.1**	---		
Iron	1000	10000	**6.9**	<1	---	---	1000	10000	**6.9**	<1	---		
Manganese	1300	2300	<1	<1	---	---	1300	2300	<1	<1	---		
Polycyclic Aromatic Hydrocarbons (PAHs)													
Benzo(A)Anthracene	2.2	---	<1	---	---	---	2.2	---	<1	---	---		
Benzo(A)Pyrene	1.0	---	<1	---	---	---	1.0	---	<1	---	---		
Benzo(G,H,I)Perylene	0.4	---	<1	---	---	---	0.4	---	<1	---	---		
Chrysene	2.0	---	<1	---	---	---	2.0	---	<1	---	---		
Dibenz(A,H)Anthracene	0.3	---	<1	---	---	---	0.3	---	<1	---	---		
Fluoranthene	7.1	---	<1	---	---	---	7.1	---	<1	---	---		
Indeno(1,2,3-C,D)Pyrene	0.3	---	<1	---	---	---	0.3	---	<1	---	---		
Pyrene	10.1	---	<1	---	---	---	10.1	---	<1	---	---		
TCL Semi-Volatile Organic Compounds (TCL SVOCs)													
Caprolactam	---	---	---	---	---	---	---	---	---	---	---		
Carbazole	---	---	---	---	---	---	---	---	---	---	---		

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-51
Surface Water Direct Contact Exposure Estimate - Flathead Riparian Area Channel
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL$_{Mean}$ Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Communities					
								NOEC$_{Inverts}$	LOEC$_{Inverts}$	Maximum EPC		Refined EPC		NOEC$_{Plants}$	LOEC$_{Plants}$	Maximum EPC		Refined EPC		NOEC$_{Fish/ Amphibians}$	LOEC$_{Fish/ Amphibians}$	Maximum EPC		Refined EPC	
										HQ$_{NOEC}$	HQ$_{LOEC}$	HQ$_{NOEC}$	HQ$_{LOEC}$			HQ$_{NOEC}$	HQ$_{LOEC}$	HQ$_{NOEC}$	HQ$_{LOEC}$			HQ$_{NOEC}$	HQ$_{LOEC}$	HQ$_{NOEC}$	HQ$_{LOEC}$
Inorganic Chemistry																									
Cyanide (Total)	U	µg/L	10	10	241	343	630	5.2	22	**121**	**28.6**	**66.0**	**15.6**	5.2	22	**121**	**28.6**	**66.0**	**15.6**	5.2	22	**121**	**28.6**	**66.0**	**15.6**
Cyanide (Total)	F	µg/L	5	5	95	184	245	5.2	22	**47.1**	**11.1**	**35.4**	**8.4**	5.2	22	**47.1**	**11.1**	**35.4**	**8.4**	5.2	22	**47.1**	**11.1**	**35.4**	**8.4**
Cyanide (Free)	U	µg/L	15	14	29	61.4	140	5.2	22	**26.9**	**6.4**	**11.8**	**2.8**	5.2	22	**26.9**	**6.4**	**11.8**	**2.8**	5.2	22	**26.9**	**6.4**	**11.8**	**2.8**
Cyanide (Free)	F	µg/L	5	5	19	44.9	63.5	5.2	22	**12.2**	**2.9**	**8.6**	**2.0**	5.2	22	**12.2**	**2.9**	**8.6**	**2.0**	5.2	22	**12.2**	**2.9**	**8.6**	**2.0**
Metals																									
Aluminum	U	µg/L	15	15	3592	25297	32000	See Sample-Specific Evaluation in Table 6-52																	
Aluminum	F	µg/L	15	11	248	292	614																		
Barium	U	µg/L	15	15	328	627	1230	3.9	39.0	**315**	**31.5**	**161**	**16.1**	3.9	39.0	**315**	**31.5**	**161**	**16.1**	3.9	39.0	**315**	**31.5**	**161**	**16.1**
Barium	F	µg/L	15	15	231	267	401	3.9	39.0	**103**	**10.3**	**69**	**6.9**	3.9	39.0	**103**	**10.3**	**68.6**	**6.9**	3.9	39.0	**103**	**10.3**	**68.6**	**6.9**
Beryllium	U	µg/L	15	3	1	NC	2	0.7	6.6	**3.0**	<1	---	---	0.7	6.6	**3.0**	<1	---	---	0.7	6.6	**3.0**	<1	---	---
Copper	U	µg/L	15	12	12	30	67.7	See Sample-Specific Evaluation in Table 6-52																	
Iron	U	µg/L	15	15	7172	17093	52100	1000	10000	**52.1**	**5.2**	**17.1**	**1.7**	1000	10000	**52.1**	**5.2**	**17.1**	**1.7**	1000.0	10000.0	**52.1**	**5.2**	**17.1**	**1.7**
Iron	F	µg/L	15	15	1372	8108	10200	1000	10000	**10.2**	1.0	**8.1**	<1	1000	10000	**10.2**	1.0	**8.1**	<1	1000.0	10000.0	**10.2**	1.0	**8.1**	<1
Lead	U	µg/L	15	11	6	21	38.5	See Sample-Specific Evaluation in Table 6-52																	
Manganese	U	µg/L	15	15	679	1404	2570	1300	2300	**2.0**	**1.1**	**1.1**	<1	1300	2300	**2.0**	**1.1**	**1.1**	<1	1300.0	2300.0	**2.0**	**1.1**	**1.1**	<1
Manganese	F	µg/L	15	15	509	1121	2420	1300	2300	**1.9**	**1.1**	<1	<1	1300	2300	**1.9**	**1.1**	<1	<1	1300.0	2300.0	**1.9**	**1.1**	<1	<1
Vanadium	U	µg/L	15	4	18	12	46.8	19	190	**2.5**	<1	<1	<1	19	190	**2.5**	<1	<1	<1	19.0	190.0	**2.5**	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																									
Pyrene	U	µg/L	6	3	1	NC	1.8	10.1	---	<1	---	---	---	10.1	---	<1	---	---	---	10.1	---	<1	---	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																									
3- And 4- Methylphenol (Total)	U	µg/L	5	1	8	NC	7.5	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Benzaldehyde	U	µg/L	6	1	2	NC	2.3	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Caprolactam	U	µg/L	6	1	1	NC	0.97	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Carbazole	U	µg/L	6	2	2	NC	2.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ$_{LOEC}$, Hazard Quotient based on LOEC value
HQ$_{NOEC}$, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
LOEC$_{Inverts}$, Lowest Observed Effect Concentration, invertebrates
LOEC$_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
NOEC$_{Inverts}$, No Observed Effect Concentration, invertebrates
NOEC$_{Plants}$, No Observed Effect Concentration, plants
UCL$_{Mean}$, Upper confidence limit of the mean concentration

Table 6-52
Sample-Specific Surface Water Direct Contact Exposure Estimate - Flathead Riparian Area Channel
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Sample ID	Station ID	Sampling Date	Filtered Aluminum					Unfiltered Aluminum					Unfiltered Copper					Unfiltered Lead				
			Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	$NOEC_{Plants}$	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}	Result (µg/L)	NOEC	HQ_{NOEC}	LOEC	HQ_{LOEC}
CFSWP-029-SW-06222018	CFSWP-029	6/22/2018	26.1	87	<1	755	<1	537	450	**1.2**	1400	<1	0.95 U	22.9	<1	28.66918	<1	0.44	8.38	<1	215	<1
CFSWP-029-SW-10182018	CFSWP-029	10/18/2018	33.3	87	<1	756	<1	53.1	490	<1	1600	<1	5.3	23.8	<1	29.92975	<1	0.185 U	8.88	<1	228	<1
CFSWP-029-SW-11012017	CFSWP-029	11/1/2017	9.1 U	87	<1	757	<1	383	770	<1	2900	<1	0.7 U	24.3	<1	30.68452	<1	0.41	9.19	<1	236	<1
CFSWP-030-SW-06222018	CFSWP-030	6/22/2018	43.4	87	<1	758	<1	1300	470	**2.8**	1500	<1	3.3	21.8	<1	27.15198	<1	1.2	7.79	<1	200	<1
CFSWP-030-SW-10182018	CFSWP-030	10/18/2018	7.5 U	87	<1	759	<1	109	740	<1	2500	<1	2.8	17.5	<1	21.2844	<1	0.53	5.60	<1	144	<1
CFSWP-030-SW-11032017	CFSWP-030	11/3/2017	245	87	**2.8**	760	<1	11800	650	**18.2**	2400	**4.9**	24.7	19.4	**1.3**	23.84632	**1.0**	12.5	6.53	**1.9**	168	<1
CFSWP-031-SW-06222018	CFSWP-031	6/22/2018	55.4	87	<1	761	<1	237	550	<1	1900	<1	2.1	23.3	<1	29.17381	<1	0.185 U	8.58	<1	220	<1
CFSWP-031-SW-10182018	CFSWP-031	10/18/2018	594	87	**6.8**	762	<1	709	940	<1	3500	<1	15.9	21.6	<1	26.89861	<1	0.77	7.69	<1	197	<1
CFSWP-031-SW-11032017	CFSWP-031	11/3/2017	614	87	**7.1**	763	<1	888	710	**1.3**	2700	<1	3.1	33.1	<1	42.99336	<1	0.88	14.49	<1	372	<1
CFSWP-032-SW-06222018	CFSWP-032	6/22/2018	7.5 U	87	<1	764	<1	69.5	370	<1	790	<1	0.95 U	24.0	<1	30.18147	<1	0.185 U	8.98	<1	231	<1
CFSWP-032-SW-10172018	CFSWP-032	10/17/2018	238	87	**2.7**	765	<1	189	770	<1	2800	<1	2.7	22.3	<1	27.91121	<1	0.4	8.08	<1	207	<1
CFSWP-032-SW-11032017	CFSWP-032	11/3/2017	586	87	**6.7**	766	<1	32000	770	**41.6**	3000	**10.7**	67.7	26.8	**2.5**	34.06735	**2.0**	38.5	10.58	**3.6**	272	<1
CFSWP-033-SW-06222018	CFSWP-033	6/22/2018	7.5 U	87	<1	767	<1	444	550	<1	1900	<1	2.4	23.3	<1	29.17381	<1	0.37	8.58	<1	220	<1
CFSWP-033-SW-10172018	CFSWP-033	10/17/2018	242	87	**2.8**	768	<1	66	980	<1	3900	<1	3.8	26.7	<1	33.94244	<1	0.185 U	10.53	<1	270	<1
CFSWP-033-SW-11032017	CFSWP-033	11/3/2017	50.4	87	<1	769	<1	5090	760	**6.7**	2900	**1.8**	13.8	25.1	<1	31.68912	<1	5.6	9.59	<1	246	<1

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
Bold, value exceeds benchmark concentration (greater than 1)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
NOEC, No observed effect concentration

Table 6-53
Sediment Direct Contact Exposure Estimate - Cedar Creek
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic Invertebrate Communities					
							$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC	
									HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry												
Cyanide	mg/kg	9	4	0.16	0.16	0.24	0.1	1.0	**2.4**	<1	**1.6**	<1
TAL Metals												
Barium	mg/kg	9	9	123	165	249	150	300	**1.7**	<1	**1.1**	<1
Manganese	mg/kg	9	9	252	349	571	460	1100	**1.2**	<1	<1	<1
Polycyclic Aromatic Hydrocarbons (PAHs)												
$ESBTU_{13}$	ESBTU	9	9	0.065	NC	0.5	1.0	10	<1	<1	---	---
$ESBTU_{34}$	ESBTU	9	9	0.178	NC	1.3	1.0	10	**1.3**	<1	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)												
Benzaldehyde	mg/kg	9	3	0.16	NC	0.17	---	---	---	---	---	---
Carbazole	mg/kg	9	2	0.0074	NC	0.0098	---	---	---	---	---	---

Notes:
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
$ESBTU_{13}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 13 PAH model in USEPA (2003)
$ESBTU_{34}$, Equilibrium Partitioning Sediment Benchmark Toxic Units based on 34 PAH model in USEPA (2003)
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LMW, Low molecular weight
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
mg/kg, milligrams per kilogram
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-54
Pore Water Direct Contact Exposure Estimate - Cedar Creek
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Amphibian Communities					
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/ Amphibians}$	$LOEC_{Fish/ Amphibians}$	Maximum EPC		Refined EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}
TAL Metals																									
Barium	F	µg/L	6	6	146	NC	269	3.9	39.0	**69.0**	**6.9**	---	---	3.9	39.0	**69.0**	**6.9**	---	---	3.9	39.0	**69.0**	**6.9**	---	---
Iron	F	µg/L	6	5	1567	NC	3640	1000	10000	**3.6**	<1	---	---	1000	10000	**3.6**	<1	---	---	1000	10000	**3.6**	<1	---	---
Manganese	F	µg/L	6	6	997	NC	2760	1300	2300	**2.1**	**1.2**	---	---	1300	2300	**2.1**	**1.2**	---	---	1300	2300	**2.1**	**1.2**	---	---
TCL Semi-Volatile Organic Compounds (TCL SVOCs)																									
Benzaldehyde	U	µg/L	6	1	0.12	NC	0.12	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Caprolactam	U	µg/L	6	1	1.6	NC	1.6	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Isophorone	U	µg/L	6	1	0.084	NC	0.084	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
TAL, Target analyte list
TCL, Target compound list
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-55
Surface Water Direct Contact Exposure Estimate - Cedar Creek
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Fraction	Units	Number of Samples	Number of Detections	Mean Detected Concentration	UCL_{Mean} Concentration	Maximum Detected Concentration	Benthic and Pelagic Invertebrate Communities						Aquatic Plant Communities						Fish and Amphibian Commun			
								$NOEC_{Inverts}$	$LOEC_{Inverts}$	Maximum EPC		Refined EPC		$NOEC_{Plants}$	$LOEC_{Plants}$	Maximum EPC		Refined EPC		$NOEC_{Fish/Amphibians}$	$LOEC_{Fish/Amphibians}$	Maximum EPC	
										HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}	HQ_{NOEC}	HQ_{LOEC}			HQ_{NOEC}	HQ_{LOEC}
Inorganic Chemistry																							
Cyanide (Total)	U	µg/L	22	7	5.46	6.32	15.3	5.2	22.0	**2.9**	<1	**1.2**	<1	5.2	22.0	**2.9**	<1	**1.2**	<1	5.2	22.0	**2.9**	<1
Cyanide (Free)	U	µg/L	20	2	4.8	NC	7.7	5.2	22.0	**1.5**	<1	**---**	**---**	5.2	22.0	**1.5**	<1	**---**	**---**	5.2	22.0	**1.5**	<1
TAL Metals																							
Barium	U	µg/L	28	28	105	108	130	3.9	39.0	**33.3**	**3.3**	**27.7**	**2.8**	3.9	39.0	**33.3**	**3.3**	**27.7**	**2.8**	3.9	39.0	**33.3**	**3.3**
Barium	F	µg/L	16	16	99.7	105	117	3.9	39.0	**30.0**	**3.0**	**26.8**	**2.7**	3.9	39.0	**30.0**	**3.0**	**26.8**	**2.7**	3.9	39.0	**30.0**	**3.0**

Notes:
µg/L, micrograms per liter
Fraction: U, Unfiltered; F, Filtered
---, Value not applicable
Bold, value exceeds benchmark concentration (greater than 1)
EPC, Exposure point concentration
HQ, Hazard quotient
HQ_{LOEC}, Hazard Quotient based on LOEC value
HQ_{NOEC}, Hazard Quotient based on NOEC value
LOEC, Lowest observed effect concentration
$LOEC_{inverts}$, Lowest Observed Effect Concentration, invertebrates
$LOEC_{Plants}$, Lowest Observed Effect Concentration, plants
NOEC, No observed effect concentration
$NOEC_{inverts}$, No Observed Effect Concentration, invertebrates
$NOEC_{Plants}$, No Observed Effect Concentration, plants
UCL_{Mean}, Upper confidence limit of the mean concentration

Table 6-56
Summary of Refined Wildlife Hazard Quotients for Cedar Creek
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	American Dipper		Belted Kingfisher		Mink	
	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}	HQ_{NOAEL}	HQ_{LOAEL}
Inorganics - Metals						
Aluminum	--	--	--	--	--	--
Antimony	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--
Barium	1.06E+00	--	--	--	--	--
Beryllium	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--
Chromium	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--
Copper	--	--	--	--	--	--
Lead	--	--	--	--	--	--
Manganese	--	--	--	--	--	--
Mercury	--	--	--	--	--	--
Nickel	--	--	--	--	--	--
Selenium	--	--	--	--	--	--
Silver	--	--	--	--	--	--
Thallium	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--
Zinc	--	--	--	--	--	--
Inorganics - Other Inorganics						
Cyanide	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)						
Aroclor 1248	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)						
Total LMW PAHs	--	--	--	--	--	--
Total HMW PAHs	--	--	--	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs						
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)						
Methylcyclohexane	--	--	--	--	--	--
Dioxin/Furans						
Total Dioxins/Furans	--	--	--	--	--	--

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion m
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Main Plant Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE			NE	NE															NE	NE				
Antimony	NE	NE			NE	NE															NE	NE				
Arsenic	NE	NE			NE	NE															NE	NE				
Barium	NE	NE			NE	NE															NE	NE				
Beryllium	NE	NE			NE	NE															NE	NE				
Cadmium	NE	NE			NE	NE					●										NE	NE			●	
Chromium	NE	NE	●		NE	NE					●										NE	NE				
Cobalt	NE	NE			NE	NE															NE	NE				
Copper	NE	NE			NE	NE															NE	NE				
Lead	NE	NE	●		NE	NE					●										NE	NE				
Manganese	NE	NE			NE	NE															NE	NE				
Mercury	NE	NE			NE	NE															NE	NE				
Nickel	NE	NE	●		NE	NE					●										NE	NE			●	
Selenium	NE	NE			NE	NE															NE	NE				
Silver	NE	NE			NE	NE															NE	NE				
Thallium	NE	NE			NE	NE															NE	NE				
Vanadium	NE	NE	●		NE	NE															NE	NE				
Zinc	NE	NE			NE	NE					●										NE	NE				
Inorganics - Other Inorganics																										
Cyanide	NE	NE	●		NE	NE	●				●										NE	NE				
Fluoride	NE	NE	●		NE	NE					●										NE	NE				
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE			NE	NE															NE	NE				
Aroclor 1254	NE	NE			NE	NE															NE	NE				
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	●		NE	NE	●				●										NE	NE				
Total HMW PAHs	NE	NE	●	●	NE	NE	●	●	●		●	●	●		●				●		NE	NE			●	●
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE			NE	NE															NE	NE				
2,3,4,6-Tetrachlorophenol	NE	NE			NE	NE															NE	NE				
2-Chloronaphthalene	NE	NE			NE	NE															NE	NE				
Biphenyl (Diphenyl)	NE	NE			NE	NE															NE	NE				
Bis(2-ethylhexyl)phthalate	NE	NE	●	●	NE	NE					●	●									NE	NE				
Butylbenzylphthalate	NE	NE			NE	NE															NE	NE				
Dibenzofuran	NE	NE			NE	NE															NE	NE				
Di-n-butyl phthalate	NE	NE			NE	NE					●										NE	NE				
Di-n-octyl phthalate	NE	NE			NE	NE															NE	NE				
Hexachlorobenzene	NE	NE			NE	NE															NE	NE				
Hexachlorobutadiene	NE	NE			NE	NE															NE	NE				
Hexachloroethane	NE	NE			NE	NE															NE	NE				
Pentachlorophenol	NE	NE			NE	NE															NE	NE				
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE			NE	NE															NE	NE				
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	●		NE	NE					●										NE	NE			●	●

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Central Landfills Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE			NE	NE															NE	NE				
Antimony	NE	NE			NE	NE															NE	NE				
Arsenic	NE	NE			NE	NE															NE	NE				
Barium	NE	NE			NE	NE															NE	NE				
Beryllium	NE	NE			NE	NE															NE	NE				
Cadmium	NE	NE			NE	NE															NE	NE				
Chromium	NE	NE	●		NE	NE					●										NE	NE				
Cobalt	NE	NE			NE	NE															NE	NE				
Copper	NE	NE	●	●	NE	NE	●	●	●		●	●	●		●				●		NE	NE			●	●
Lead	NE	NE	●		NE	NE					●										NE	NE				
Manganese	NE	NE			NE	NE															NE	NE				
Mercury	NE	NE			NE	NE															NE	NE				
Nickel	NE	NE	●		NE	NE					●								●		NE	NE			●	●
Selenium	NE	NE			NE	NE													●		NE	NE			●	
Silver	NE	NE			NE	NE															NE	NE				
Thallium	NE	NE			NE	NE															NE	NE				
Vanadium	NE	NE	●		NE	NE															NE	NE				
Zinc	NE	NE			NE	NE															NE	NE				
Inorganics - Other Inorganics																										
Cyanide	NE	NE	●		NE	NE	●		●		●										NE	NE				
Fluoride	NE	NE	●		NE	NE	●				●										NE	NE				
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE			NE	NE															NE	NE				
Aroclor 1254	NE	NE	●	●	NE	NE					●	●			●						NE	NE			●	●
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	●		NE	NE	●				●	●									NE	NE			●	
Total HMW PAHs	NE	NE	●	●	NE	NE	●	●			●	●	●		●				●		NE	NE			●	●
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE			NE	NE															NE	NE				
2,3,4,6-Tetrachlorophenol	NE	NE			NE	NE															NE	NE				
2-Chloronaphthalene	NE	NE			NE	NE															NE	NE				
Biphenyl (Diphenyl)	NE	NE			NE	NE															NE	NE				
Bis(2-ethylhexyl)phthalate	NE	NE	I	I	NE	NE					●	●									NE	NE				
Butylbenzylphthalate	NE	NE			NE	NE															NE	NE				
Dibenzofuran	NE	NE			NE	NE															NE	NE				
Di-n-butyl phthalate	NE	NE			NE	NE															NE	NE				
Di-n-octyl phthalate	NE	NE			NE	NE															NE	NE				
Hexachlorobenzene	NE	NE			NE	NE															NE	NE				
Hexachlorobutadiene	NE	NE			NE	NE															NE	NE				
Hexachloroethane	NE	NE			NE	NE															NE	NE				
Pentachlorophenol	NE	NE			NE	NE															NE	NE				
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE			NE	NE															NE	NE				
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE			NE	NE					●										NE	NE			●	

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Industrial Landfills Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE			NE	NE															NE	NE				
Antimony	NE	NE			NE	NE															NE	NE			●	
Arsenic	NE	NE			NE	NE															NE	NE				
Barium	NE	NE			NE	NE															NE	NE				
Beryllium	NE	NE			NE	NE															NE	NE				
Cadmium	NE	NE			NE	NE															NE	NE			●	
Chromium	NE	NE			NE	NE															NE	NE				
Cobalt	NE	NE			NE	NE															NE	NE				
Copper	NE	NE			NE	NE					●										NE	NE			●	
Lead	NE	NE			NE	NE															NE	NE				
Manganese	NE	NE			NE	NE															NE	NE				
Mercury	NE	NE			NE	NE															NE	NE				
Nickel	NE	NE	●	●	NE	NE					●	●							●		NE	NE			●	●
Selenium	NE	NE			NE	NE															NE	NE				
Silver	NE	NE			NE	NE															NE	NE				
Thallium	NE	NE			NE	NE															NE	NE				
Vanadium	NE	NE	●	●	NE	NE	●		●		●										NE	NE				
Zinc	NE	NE			NE	NE															NE	NE				
Inorganics - Other Inorganics																										
Cyanide	NE	NE	●		NE	NE					●										NE	NE				
Fluoride	NE	NE			NE	NE															NE	NE				
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE			NE	NE															NE	NE				
Aroclor 1254	NE	NE			NE	NE															NE	NE				
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	●		NE	NE					●										NE	NE				
Total HMW PAHs	NE	NE	●	●	NE	NE	●				●	●			●				●		NE	NE			●	
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE			NE	NE															NE	NE				
2,3,4,6-Tetrachlorophenol	NE	NE			NE	NE															NE	NE				
2-Chloronaphthalene	NE	NE			NE	NE															NE	NE				
Biphenyl (Diphenyl)	NE	NE			NE	NE															NE	NE				
Bis(2-ethylhexyl)phthalate	NE	NE			NE	NE															NE	NE				
Butylbenzylphthalate	NE	NE			NE	NE															NE	NE				
Dibenzofuran	NE	NE			NE	NE															NE	NE				
Di-n-butyl phthalate	NE	NE			NE	NE															NE	NE				
Di-n-octyl phthalate	NE	NE			NE	NE															NE	NE				
Hexachlorobenzene	NE	NE			NE	NE															NE	NE				
Hexachlorobutadiene	NE	NE			NE	NE															NE	NE				
Hexachloroethane	NE	NE			NE	NE															NE	NE				
Pentachlorophenol	NE	NE			NE	NE															NE	NE				
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE			NE	NE															NE	NE				
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE			NE	NE															NE	NE				

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Eastern Undeveloped Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE			NE	NE															NE	NE				
Antimony	NE	NE			NE	NE															NE	NE				
Arsenic	NE	NE			NE	NE															NE	NE				
Barium	NE	NE			NE	NE															NE	NE				
Beryllium	NE	NE			NE	NE															NE	NE				
Cadmium	NE	NE			NE	NE															NE	NE				
Chromium	NE	NE			NE	NE															NE	NE				
Cobalt	NE	NE			NE	NE															NE	NE				
Copper	NE	NE			NE	NE															NE	NE				
Lead	NE	NE	●		NE	NE					●										NE	NE				
Manganese	NE	NE			NE	NE															NE	NE				
Mercury	NE	NE			NE	NE															NE	NE				
Nickel	NE	NE			NE	NE					●										NE	NE			●	
Selenium	NE	NE			NE	NE															NE	NE				
Silver	NE	NE			NE	NE															NE	NE				
Thallium	NE	NE			NE	NE															NE	NE				
Vanadium	NE	NE	●		NE	NE															NE	NE				
Zinc	NE	NE			NE	NE					●										NE	NE				
Inorganics - Other Inorganics																										
Cyanide	NE	NE	●		NE	NE	●				●										NE	NE				
Fluoride	NE	NE			NE	NE															NE	NE				
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE			NE	NE															NE	NE				
Aroclor 1254	NE	NE			NE	NE															NE	NE				
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE			NE	NE															NE	NE				
Total HMW PAHs	NE	NE			NE	NE															NE	NE				
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE			NE	NE															NE	NE				
2,3,4,6-Tetrachlorophenol	NE	NE			NE	NE															NE	NE				
2-Chloronaphthalene	NE	NE			NE	NE															NE	NE				
Biphenyl (Diphenyl)	NE	NE			NE	NE															NE	NE				
Bis(2-ethylhexyl)phthalate	NE	NE			NE	NE					●										NE	NE				
Butylbenzylphthalate	NE	NE			NE	NE															NE	NE				
Dibenzofuran	NE	NE			NE	NE															NE	NE				
Di-n-butyl phthalate	NE	NE			NE	NE															NE	NE				
Di-n-octyl phthalate	NE	NE			NE	NE															NE	NE				
Hexachlorobenzene	NE	NE			NE	NE															NE	NE				
Hexachlorobutadiene	NE	NE			NE	NE															NE	NE				
Hexachloroethane	NE	NE			NE	NE															NE	NE				
Pentachlorophenol	NE	NE			NE	NE															NE	NE				
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE			NE	NE															NE	NE				
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE			NE	NE															NE	NE				

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
North-Central Undeveloped Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE			NE	NE															NE	NE				
Antimony	NE	NE			NE	NE															NE	NE				
Arsenic	NE	NE			NE	NE															NE	NE				
Barium	NE	NE			NE	NE															NE	NE				
Beryllium	NE	NE			NE	NE															NE	NE				
Cadmium	NE	NE			NE	NE															NE	NE				
Chromium	NE	NE			NE	NE															NE	NE				
Cobalt	NE	NE			NE	NE															NE	NE				
Copper	NE	NE			NE	NE															NE	NE				
Lead	NE	NE			NE	NE															NE	NE				
Manganese	NE	NE			NE	NE															NE	NE				
Mercury	NE	NE			NE	NE															NE	NE				
Nickel	NE	NE			NE	NE															NE	NE				
Selenium	NE	NE			NE	NE															NE	NE				
Silver	NE	NE			NE	NE															NE	NE				
Thallium	NE	NE			NE	NE															NE	NE				
Vanadium	NE	NE			NE	NE															NE	NE				
Zinc	NE	NE			NE	NE															NE	NE				
Inorganics - Other Inorganics																										
Cyanide	NE	NE	●		NE	NE	●				●										NE	NE				
Fluoride	NE	NE			NE	NE															NE	NE				
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE			NE	NE															NE	NE				
Aroclor 1254	NE	NE			NE	NE															NE	NE				
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE			NE	NE															NE	NE				
Total HMW PAHs	NE	NE			NE	NE															NE	NE				
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE			NE	NE															NE	NE				
2,3,4,6-Tetrachlorophenol	NE	NE			NE	NE															NE	NE				
2-Chloronaphthalene	NE	NE			NE	NE															NE	NE				
Biphenyl (Diphenyl)	NE	NE			NE	NE															NE	NE				
Bis(2-ethylhexyl)phthalate	NE	NE	●		NE	NE					●										NE	NE				
Butylbenzylphthalate	NE	NE			NE	NE															NE	NE				
Dibenzofuran	NE	NE			NE	NE															NE	NE				
Di-n-butyl phthalate	NE	NE			NE	NE															NE	NE				
Di-n-octyl phthalate	NE	NE			NE	NE															NE	NE				
Hexachlorobenzene	NE	NE			NE	NE															NE	NE				
Hexachlorobutadiene	NE	NE			NE	NE															NE	NE				
Hexachloroethane	NE	NE			NE	NE															NE	NE				
Pentachlorophenol	NE	NE			NE	NE															NE	NE				
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE			NE	NE															NE	NE				
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE			NE	NE															NE	NE				

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Western Undeveloped Area (Soil)																												
Inorganics - Metals																												
Aluminum	NE	NE			NE	NE															NE	NE						
Antimony	NE	NE			NE	NE															NE	NE						
Arsenic	NE	NE			NE	NE															NE	NE						
Barium	NE	NE			NE	NE															NE	NE						
Beryllium	NE	NE			NE	NE															NE	NE						
Cadmium	NE	NE			NE	NE															NE	NE						
Chromium	NE	NE			NE	NE															NE	NE						
Cobalt	NE	NE			NE	NE															NE	NE						
Copper	NE	NE			NE	NE															NE	NE						
Lead	NE	NE	●		NE	NE					●										NE	NE						
Manganese	NE	NE			NE	NE															NE	NE						
Mercury	NE	NE			NE	NE															NE	NE						
Nickel	NE	NE			NE	NE															NE	NE						
Selenium	NE	NE			NE	NE															NE	NE						
Silver	NE	NE			NE	NE															NE	NE						
Thallium	NE	NE			NE	NE															NE	NE						
Vanadium	NE	NE			NE	NE															NE	NE						
Zinc	NE	NE			NE	NE					●										NE	NE						
Inorganics - Other Inorganics																												
Cyanide	NE	NE	●		NE	NE	●				●										NE	NE						
Fluoride	NE	NE			NE	NE															NE	NE						
Polychlorinated Biphenyls (PCBs)																												
Aroclor 1248	NE	NE			NE	NE															NE	NE						
Aroclor 1254	NE	NE			NE	NE															NE	NE						
Polycyclic Aromatic Hydrocarbons (PAHs)																												
Total LMW PAHs	NE	NE			NE	NE															NE	NE						
Total HMW PAHs	NE	NE			NE	NE															NE	NE						
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																												
1,2,4,5-Tetrachlorobenzene	NE	NE			NE	NE															NE	NE						
2,3,4,6-Tetrachlorophenol	NE	NE			NE	NE															NE	NE						
2-Chloronaphthalene	NE	NE			NE	NE															NE	NE						
Biphenyl (Diphenyl)	NE	NE			NE	NE															NE	NE						
Bis(2-ethylhexyl)phthalate	NE	NE	●		NE	NE					●										NE	NE						
Butylbenzylphthalate	NE	NE			NE	NE															NE	NE						
Dibenzofuran	NE	NE			NE	NE															NE	NE						
Di-n-butyl phthalate	NE	NE			NE	NE															NE	NE						
Di-n-octyl phthalate	NE	NE			NE	NE															NE	NE						
Hexachlorobenzene	NE	NE			NE	NE															NE	NE						
Hexachlorobutadiene	NE	NE			NE	NE															NE	NE						
Hexachloroethane	NE	NE			NE	NE															NE	NE						
Pentachlorophenol	NE	NE			NE	NE															NE	NE						
Volatile Organic Compounds (VOCs)																												
Methylcyclohexane	NE	NE			NE	NE															NE	NE						
Dioxin/Furans																												
Total Dioxins/Furans	NE	NE			NE	NE															NE	NE			●			

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Flathead River Riparian Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE			NE	NE															NE	NE				
Antimony	NE	NE			NE	NE															NE	NE				
Arsenic	NE	NE			NE	NE															NE	NE				
Barium	NE	NE			NE	NE															NE	NE				
Beryllium	NE	NE			NE	NE															NE	NE				
Cadmium	NE	NE			NE	NE															NE	NE				
Chromium	NE	NE			NE	NE															NE	NE				
Cobalt	NE	NE			NE	NE															NE	NE				
Copper	NE	NE			NE	NE															NE	NE				
Lead	NE	NE			NE	NE															NE	NE				
Manganese	NE	NE			NE	NE															NE	NE				
Mercury	NE	NE			NE	NE															NE	NE				
Nickel	NE	NE			NE	NE															NE	NE				
Selenium	NE	NE			NE	NE															NE	NE				
Silver	NE	NE			NE	NE															NE	NE				
Thallium	NE	NE			NE	NE															NE	NE				
Vanadium	NE	NE			NE	NE															NE	NE				
Zinc	NE	NE			NE	NE															NE	NE				
Inorganics - Other Inorganics																										
Cyanide	NE	NE	●		NE	NE	●				●										NE	NE				
Fluoride	NE	NE			NE	NE															NE	NE				
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE			NE	NE															NE	NE				
Aroclor 1254	NE	NE			NE	NE															NE	NE				
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE			NE	NE															NE	NE				
Total HMW PAHs	NE	NE			NE	NE															NE	NE				
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE			NE	NE															NE	NE				
2,3,4,6-Tetrachlorophenol	NE	NE			NE	NE															NE	NE				
2-Chloronaphthalene	NE	NE			NE	NE															NE	NE				
Biphenyl (Diphenyl)	NE	NE			NE	NE															NE	NE				
Bis(2-ethylhexyl)phthalate	NE	NE			NE	NE															NE	NE				
Butylbenzylphthalate	NE	NE			NE	NE															NE	NE				
Dibenzofuran	NE	NE			NE	NE															NE	NE				
Di-n-butyl phthalate	NE	NE			NE	NE															NE	NE				
Di-n-octyl phthalate	NE	NE			NE	NE															NE	NE				
Hexachlorobenzene	NE	NE			NE	NE															NE	NE				
Hexachlorobutadiene	NE	NE			NE	NE															NE	NE				
Hexachloroethane	NE	NE			NE	NE															NE	NE				
Pentachlorophenol	NE	NE			NE	NE															NE	NE				
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE			NE	NE															NE	NE				
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE			NE	NE															NE	NE				

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
North Percolation Pond (Transitional, soil/sediment)																										
Inorganics - Metals																										
Aluminum																										
Antimony																									●	
Arsenic																										
Barium	●	●																								
Beryllium																			●							
Cadmium			●								●	●													●	
Chromium																										
Cobalt																										
Copper	●		●								●															
Lead	●		●				●				●														●	
Manganese																										
Mercury																										
Nickel	●	●	●	●			●				●	●	●		●				●						●	●
Selenium	●	●	●								●								●						●	
Silver																										
Thallium																										
Vanadium	●	●	●	●	●		●	●	●		●	●														
Zinc	●		●								●														●	
Inorganics - Other Inorganics																										
Cyanide	●	●	●	●			●	●	●																	
Fluoride																										
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248																										
Aroclor 1254																										
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	●	●	●	●	●	●	●	●			●	●			●				●						●	●
Total HMW PAHs	●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●		●	●			●		●	●
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene																										
2,3,4,6-Tetrachlorophenol																										
2-Chloronaphthalene																										
Biphenyl (Diphenyl)																										
Bis(2-ethylhexyl)phthalate											●														●	
Butylbenzylphthalate																										
Dibenzofuran																										
Di-n-butyl phthalate																										
Di-n-octyl phthalate																										
Hexachlorobenzene																										
Hexachlorobutadiene																										
Hexachloroethane																										
Pentachlorophenol																										
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane																										
Dioxin/Furans																										
Total Dioxins/Furans																										

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
South Percolation Pond (Transitional, soil/sediment)																												
Inorganics - Metals																												
Aluminum																												
Antimony																												
Arsenic																												
Barium	●	●																										
Beryllium																												
Cadmium			●								●																●	
Chromium																												
Cobalt																												
Copper	●	●	●	●	●		●				●	●															●	
Lead	●		●								●																	
Manganese																												
Mercury	●		●								●																	
Nickel																											●	
Selenium																												
Silver							●																					
Thallium																												
Vanadium	●																											
Zinc			●								●																	
Inorganics - Other Inorganics																												
Cyanide	●		●				●		●																			
Fluoride																												
Polychlorinated Biphenyls (PCBs)																												
Aroclor 1248																												
Aroclor 1254																												
Polycyclic Aromatic Hydrocarbons (PAHs)																												
Total LMW PAHs																												
Total HMW PAHs	●																										●	
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																												
1,2,4,5-Tetrachlorobenzene																												
2,3,4,6-Tetrachlorophenol																												
2-Chloronaphthalene																												
Biphenyl (Diphenyl)																												
Bis(2-ethylhexyl)phthalate			●	●							●	●																
Butylbenzylphthalate																												
Dibenzofuran																												
Di-n-butyl phthalate																												
Di-n-octyl phthalate																												
Hexachlorobenzene																												
Hexachlorobutadiene																												
Hexachloroethane																												
Pentachlorophenol																												
Volatile Organic Compounds (VOCs)																												
Methylcyclohexane																												
Dioxin/Furans																												
Total Dioxins/Furans																												

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Cedar Creek Reservoir Overflow Ditch (Transitional, soil/sediment)																										
Inorganics - Metals																										
Aluminum																										
Antimony																●										
Arsenic																										
Barium	●	●																								
Beryllium																										
Cadmium																										
Chromium																										
Cobalt																										
Copper																										
Lead																										
Manganese																										
Mercury																										
Nickel																									●	
Selenium																									●	
Silver																										
Thallium																										
Vanadium	●																									
Zinc											●															
Inorganics - Other Inorganics																										
Cyanide																										
Fluoride																										
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248																										
Aroclor 1254																										
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs																										
Total HMW PAHs	●																									
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene																										
2,3,4,6-Tetrachlorophenol																										
2-Chloronaphthalene																										
Biphenyl (Diphenyl)																										
Bis(2-ethylhexyl)phthalate																										
Butylbenzylphthalate																										
Dibenzofuran																										
Di-n-butyl phthalate																										
Di-n-octyl phthalate																										
Hexachlorobenzene																										
Hexachlorobutadiene																										
Hexachloroethane																										
Pentachlorophenol																										
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane																										
Dioxin/Furans																										
Total Dioxins/Furans																										

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Northern Surface Water Feature (Transitional, soil/sediment)																										
Inorganics - Metals																										
Aluminum																										
Antimony																										
Arsenic																										
Barium	●	●																								
Beryllium																										
Cadmium																										
Chromium																										
Cobalt																										
Copper	●																									
Lead																										
Manganese																										
Mercury																										
Nickel																										
Selenium	●	●	●				●				●								●						●	
Silver																										
Thallium																										
Vanadium	●																									
Zinc																										
Inorganics - Other Inorganics																										
Cyanide																										
Fluoride																										
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248																										
Aroclor 1254																										
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs																										
Total HMW PAHs																										
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene																										
2,3,4,6-Tetrachlorophenol																										
2-Chloronaphthalene																										
Biphenyl (Diphenyl)																										
Bis(2-ethylhexyl)phthalate																										
Butylbenzylphthalate																										
Dibenzofuran																										
Di-n-butyl phthalate																										
Di-n-octyl phthalate																										
Hexachlorobenzene																										
Hexachlorobutadiene																										
Hexachloroethane																										
Pentachlorophenol																										
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane																										
Dioxin/Furans																										
Total Dioxins/Furans																										

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Flathead River Area (Surface Water/Sediment)																												
Inorganics - Metals																												
Aluminum			NE	NE	●		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Antimony			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Arsenic			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Barium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Beryllium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Cadmium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Chromium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Cobalt			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Copper			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Lead			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Manganese			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Mercury			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Nickel			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Selenium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Silver			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Thallium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Vanadium	●		NE	NE	●		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Zinc			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Inorganics - Other Inorganics																												
Cyanide	●		NE	NE	●		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Fluoride			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)																												
Aroclor 1248			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Aroclor 1254			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)																												
Total LMW PAHs			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Total HMW PAHs	●		NE	NE	●		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	●		NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																												
1,2,4,5-Tetrachlorobenzene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
2-Chloronaphthalene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Biphenyl (Diphenyl)			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Butylbenzylphthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Dibenzofuran			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Di-n-butyl phthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Di-n-octyl phthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Hexachlorobenzene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Hexachlorobutadiene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Hexachloroethane			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Pentachlorophenol			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Volatile Organic Compounds (VOCs)																												
Methylcyclohexane			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Dioxin/Furans																												
Total Dioxins/Furans			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE

Table 6-57
Summary of Wildlife Hazard Quotients Calculated using Max EPC
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Cedar Creek Area (Surface Water/Sediment)																												
Inorganics - Metals																												
Aluminum			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Antimony			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Arsenic			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Barium	●		NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Beryllium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Cadmium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Chromium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Cobalt			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Copper			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Lead			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Manganese			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Mercury			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Nickel			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Selenium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Silver			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Thallium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Vanadium			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Zinc			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Inorganics - Other Inorganics																												
Cyanide			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Fluoride			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)																												
Aroclor 1248			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Aroclor 1254			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)																												
Total LMW PAHs			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Total HMW PAHs			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																												
1,2,4,5-Tetrachlorobenzene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
2-Chloronaphthalene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Biphenyl (Diphenyl)			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Butylbenzylphthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Dibenzofuran			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Di-n-butyl phthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Di-n-octyl phthalate			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Hexachlorobenzene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Hexachlorobutadiene			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Hexachloroethane			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Pentachlorophenol			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Volatile Organic Compounds (VOCs)																												
Methylcyclohexane			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE
Dioxin/Furans																												
Total Dioxins/Furans			NE	NE			NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE			NE	NE	NE	NE

Notes:

NE: Receptor was not evaluated for the exposure area
Blank: HQ <1 or not measured
HQ: Hazard Quotient
NOAEL: No Observed Adverse Effects Level
LOAEL: Lowest Observed Adverse Effects Level
I: HQ>1
Shaded cells indicate LOAEL results for endangered species, which are evaluated based on their NOAEL results only.

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Main Plant Area (Soil)														
Inorganics - Metals														
Aluminum	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Arsenic	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Barium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cadmium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Chromium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cobalt	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Copper	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Lead	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Manganese	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Mercury	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Nickel	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Selenium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Silver	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Thallium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Vanadium	NE	NE	--	--	NE	NE	<1	--	<1	--	--	--	--	--
Zinc	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	NE	NE	--	--	NE	NE	<1	--	<1	--	--	--	--	--
Fluoride	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	NE	NE	--	--	NE	NE	<1	--	--	--	**1.0**	--	--	--
Total HMW PAHs	NE	NE	**13.9**	**1.4**	NE	NE	**1.6**	<1	<1	--	**19.7**	**2.0**	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	**2.8**	--	NE	NE	--	--	--	--	**4.2**	--	--	--
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	NE	NE	**1.8**	--	NE	NE	--	--	--	--	**2.7**	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	--	--	--	--	--	--	NE	NE	--	--	--	--
Arsenic	--	--	--	--	--	--	NE	NE	--	--	--	--
Barium	--	--	--	--	--	--	NE	NE	--	--	--	--
Beryllium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cadmium	--	--	--	--	--	--	NE	NE	--	--	--	--
Chromium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cobalt	--	--	--	--	--	--	NE	NE	--	--	--	--
Copper	--	--	--	--	--	--	NE	NE	--	--	--	--
Lead	--	--	--	--	--	--	NE	NE	--	--	--	--
Manganese	--	--	--	--	--	--	NE	NE	--	--	--	--
Mercury	--	--	--	--	--	--	NE	NE	--	--	--	--
Nickel	--	--	--	--	--	--	NE	NE	--	--	1.1	--
Selenium	--	--	--	--	--	--	NE	NE	--	--	--	--
Silver	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	--	--	--	--	--	--	NE	NE	--	--	--	--
Vanadium	--	--	--	--	--	--	NE	NE	--	--	--	--
Zinc	--	--	--	--	--	--	NE	NE	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	NE	NE	--	--	--	--
Fluoride	--	--	--	--	--	--	NE	NE	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	NE	NE	--	--	--	--
Total HMW PAHs	<1	<1	--	--	3.6	--	NE	NE	<1	--	22.8	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	NE	NE	--	--	3.4	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Central Landfills Area (Soil)														
Inorganics - Metals														
Aluminum	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Barium	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Copper	NE	NE	11.3	1.3	--	--	<1	--	--	--	14.5	1.7	--	--
Lead	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Silver	NE	NE	--	--	--	--	<1	--	--	--	--	--	--	--
Thallium	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	NE	NE	--	--	--	--	<1	--	<1	--	--	--	--	--
Zinc	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	NE	NE	--	--	--	--	<1	--	<1	--	--	--	--	--
Fluoride	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	NE	NE	20.7	2.1	--	--	--	--	--	--	30.9	3.1	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	NE	NE	--	--	--	--	<1	--	--	--	1.4	--	--	--
Total HMW PAHs	NE	NE	9.7	--	--	--	1.6	<1	<1	--	13.8	1.4	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	1.5	--	--	--	--	--	--	--	2.2	--	--	--
Butylbenzylphthalate	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	NE	NE	--	--	--	--	--	--	--	--	1.1	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	--	--	--	--	--	--	NE	NE	--	--	--	--
Arsenic	--	--	--	--	--	--	NE	NE	--	--	--	--
Barium	--	--	--	--	--	--	NE	NE	--	--	--	--
Beryllium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cadmium	--	--	--	--	--	--	NE	NE	--	--	--	--
Chromium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cobalt	--	--	--	--	--	--	NE	NE	--	--	--	--
Copper	--	--	--	--	--	--	NE	NE	--	--	2.4	--
Lead	--	--	--	--	--	--	NE	NE	--	--	--	--
Manganese	--	--	--	--	--	--	NE	NE	--	--	--	--
Mercury	--	--	--	--	--	--	NE	NE	--	--	--	--
Nickel	--	--	--	--	--	--	NE	NE	--	--	3.7	--
Selenium	--	--	--	--	--	--	NE	NE	--	--	--	--
Silver	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	--	--	--	--	--	--	NE	NE	--	--	--	--
Vanadium	--	--	--	--	--	--	NE	NE	--	--	--	--
Zinc	--	--	--	--	--	--	NE	NE	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	NE	NE	--	--	--	--
Fluoride	--	--	--	--	--	--	NE	NE	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	NE	NE	--	--	5.9	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	NE	NE	--	--	--	--
Total HMW PAHs	<1	<1	--	--	5.0	--	NE	NE	<1	--	33.4	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	NE	NE	--	--	2.9	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Industrial Landfills Area (Soil)														
Inorganics - Metals														
Aluminum	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Arsenic	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Barium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cadmium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Chromium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cobalt	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Copper	NE	NE	--	--	NE	NE	<1	--	--	--	<1	--	--	--
Lead	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Manganese	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Mercury	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Nickel	NE	NE	5.7	2.1	NE	NE	--	--	--	--	2.3	<1	--	--
Selenium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Thallium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Vanadium	NE	NE	5.9	1.2	NE	NE	<1	--	<1	--	<1	--	--	--
Zinc	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	NE	NE	--	--	NE	NE	<1	--	<1	--	--	--	--	--
Fluoride	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)			--	--			--	--	--	--	--	--	--	--
Total LMW PAHs	NE	NE	1.9	--	NE	NE	<1	--	--	--	<1	--	--	--
Total HMW PAHs	NE	NE	35.4	3.5	NE	NE	1.5	<1	<1	--	15.1	1.5	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	--	--	--	--	--	--	NE	NE	--	--	**6.6**	--
Arsenic	--	--	--	--	--	--	NE	NE	--	--	--	--
Barium	--	--	--	--	--	--	NE	NE	--	--	--	--
Beryllium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cadmium	--	--	--	--	--	--	NE	NE	--	--	**1.6**	--
Chromium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cobalt	--	--	--	--	--	--	NE	NE	--	--	--	--
Copper	--	--	--	--	--	--	NE	NE	--	--	**6.7**	--
Lead	--	--	--	--	--	--	NE	NE	--	--	--	--
Manganese	--	--	--	--	--	--	NE	NE	--	--	--	--
Mercury	--	--	--	--	--	--	NE	NE	--	--	--	--
Nickel	--	--	--	--	**1.4**	--	NE	NE	--	--	**28.1**	**3.2**
Selenium	--	--	--	--	--	--	NE	NE	--	--	--	--
Silver	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	--	--	--	--	--	--	NE	NE	--	--	--	--
Vanadium	--	--	--	--	--	--	NE	NE	--	--	--	--
Zinc	--	--	--	--	--	--	NE	NE	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	NE	NE	--	--	--	--
Fluoride	--	--	--	--	--	--	NE	NE	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)	--	--	--	--	--	--			--	--	--	--
Total LMW PAHs	--	--	--	--	--	--	NE	NE	--	--	--	--
Total HMW PAHs	<1	<1	--	--	**6.9**	--	NE	NE	<1	--	**38.2**	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	NE	NE	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Eastern Undeveloped Area (Soil)														
Inorganics - Metals														
Aluminum	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Arsenic	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Barium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cadmium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Chromium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cobalt	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Copper	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Lead	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Manganese	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Mercury	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Nickel	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Selenium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Silver	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Thallium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Vanadium	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Zinc	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Fluoride	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Total HMW PAHs	NE	NE	--	--	NE	NE	<1	<1	--	--	--	--	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	--	--	NE	NE	--	--	--	--	**1.2**	--	--	--
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	--	--	--	--	--	--	NE	NE	--	--	--	--
Arsenic	--	--	--	--	--	--	NE	NE	--	--	--	--
Barium	--	--	--	--	--	--	NE	NE	--	--	--	--
Beryllium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cadmium	--	--	--	--	--	--	NE	NE	--	--	--	--
Chromium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cobalt	--	--	--	--	--	--	NE	NE	--	--	--	--
Copper	--	--	--	--	--	--	NE	NE	--	--	--	--
Lead	--	--	--	--	--	--	NE	NE	--	--	--	--
Manganese	--	--	--	--	--	--	NE	NE	--	--	--	--
Mercury	--	--	--	--	--	--	NE	NE	--	--	--	--
Nickel	--	--	--	--	--	--	NE	NE	--	--	**1.0**	--
Selenium	--	--	--	--	--	--	NE	NE	--	--	--	--
Silver	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	--	--	--	--	--	--	NE	NE	--	--	--	--
Vanadium	--	--	--	--	--	--	NE	NE	--	--	--	--
Zinc	--	--	--	--	--	--	NE	NE	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	NE	NE	--	--	--	--
Fluoride	--	--	--	--	--	--	NE	NE	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	NE	NE	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	NE	NE	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	NE	NE	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
North-Central Undeveloped Area (Soil)														
Inorganics - Metals														
Aluminum	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Arsenic	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Barium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cadmium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Chromium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cobalt	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Copper	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Lead	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Manganese	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Mercury	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Nickel	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Selenium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Thallium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Vanadium	NE	NE	--	--	NE	NE	<1	--	<1	--	--	--	--	--
Zinc	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	NE	NE	--	--	NE	NE	<1	--	<1	--	--	--	--	--
Fluoride	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Total HMW PAHs	NE	NE	--	--	NE	NE	**1.5**	<1	<1	--	--	--	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	--	--	--	--	--	--	NE	NE	--	--	--	--
Arsenic	--	--	--	--	--	--	NE	NE	--	--	--	--
Barium	--	--	--	--	--	--	NE	NE	--	--	--	--
Beryllium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cadmium	--	--	--	--	--	--	NE	NE	--	--	--	--
Chromium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cobalt	--	--	--	--	--	--	NE	NE	--	--	--	--
Copper	--	--	--	--	--	--	NE	NE	--	--	--	--
Lead	--	--	--	--	--	--	NE	NE	--	--	--	--
Manganese	--	--	--	--	--	--	NE	NE	--	--	--	--
Mercury	--	--	--	--	--	--	NE	NE	--	--	--	--
Nickel	--	--	--	--	--	--	NE	NE	--	--	--	--
Selenium	--	--	--	--	--	--	NE	NE	--	--	--	--
Silver	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	--	--	--	--	--	--	NE	NE	--	--	--	--
Vanadium	--	--	--	--	--	--	NE	NE	--	--	--	--
Zinc	--	--	--	--	--	--	NE	NE	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	NE	NE	--	--	--	--
Fluoride	--	--	--	--	--	--	NE	NE	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	NE	NE	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	NE	NE	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	NE	NE	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
										Western Undeveloped Area (Soil)				
Inorganics - Metals														
Aluminum	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Arsenic	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Barium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cadmium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Chromium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cobalt	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Copper	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Lead	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Manganese	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Mercury	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Nickel	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Selenium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Silver	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Thallium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Vanadium	NE	NE	--	--	NE	NE	<1	--	<1	--	--	--	--	--
Zinc	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	NE	NE	--	--	NE	NE	<1	--	<1	--	--	--	--	--
Fluoride	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Total HMW PAHs	NE	NE	--	--	NE	NE	**1.5**	<1	<1	--	--	--	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	--	--	--	--	--	--	NE	NE	--	--	--	--
Arsenic	--	--	--	--	--	--	NE	NE	--	--	--	--
Barium	--	--	--	--	--	--	NE	NE	--	--	--	--
Beryllium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cadmium	--	--	--	--	--	--	NE	NE	--	--	--	--
Chromium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cobalt	--	--	--	--	--	--	NE	NE	--	--	--	--
Copper	--	--	--	--	--	--	NE	NE	--	--	--	--
Lead	--	--	--	--	--	--	NE	NE	--	--	--	--
Manganese	--	--	--	--	--	--	NE	NE	--	--	--	--
Mercury	--	--	--	--	--	--	NE	NE	--	--	--	--
Nickel	--	--	--	--	--	--	NE	NE	--	--	--	--
Selenium	--	--	--	--	--	--	NE	NE	--	--	--	--
Silver	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	--	--	--	--	--	--	NE	NE	--	--	--	--
Vanadium	--	--	--	--	--	--	NE	NE	--	--	--	--
Zinc	--	--	--	--	--	--	NE	NE	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	NE	NE	--	--	--	--
Fluoride	--	--	--	--	--	--	NE	NE	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	NE	NE	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	NE	NE	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	NE	NE	--	--	1.1	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Flathead River Riparian Area (Soil)														
Inorganics - Metals														
Aluminum	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Arsenic	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Barium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cadmium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Chromium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Cobalt	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Copper	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Lead	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Manganese	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Mercury	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Nickel	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Selenium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Silver	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Thallium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Vanadium	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Zinc	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Fluoride	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	NE	NE	--	--	NE	NE	<1	--	--	--	--	--	--	--
Total HMW PAHs	NE	NE	--	--	NE	NE	**1.5**	<1	--	--	--	--	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	--	--	--	--	--	--	NE	NE	--	--	--	--
Arsenic	--	--	--	--	--	--	NE	NE	--	--	--	--
Barium	--	--	--	--	--	--	NE	NE	--	--	--	--
Beryllium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cadmium	--	--	--	--	--	--	NE	NE	--	--	--	--
Chromium	--	--	--	--	--	--	NE	NE	--	--	--	--
Cobalt	--	--	--	--	--	--	NE	NE	--	--	--	--
Copper	--	--	--	--	--	--	NE	NE	--	--	--	--
Lead	--	--	--	--	--	--	NE	NE	--	--	--	--
Manganese	--	--	--	--	--	--	NE	NE	--	--	--	--
Mercury	--	--	--	--	--	--	NE	NE	--	--	--	--
Nickel	--	--	--	--	--	--	NE	NE	--	--	--	--
Selenium	--	--	--	--	--	--	NE	NE	--	--	--	--
Silver	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	--	--	--	--	--	--	NE	NE	--	--	--	--
Vanadium	--	--	--	--	--	--	NE	NE	--	--	--	--
Zinc	--	--	--	--	--	--	NE	NE	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	NE	NE	--	--	--	--
Fluoride	--	--	--	--	--	--	NE	NE	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	NE	NE	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	NE	NE	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	NE	NE	--	--	--	--

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
North Percolation Pond (Transitional, soil/sedime														
Inorganics - Metals														
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	1.6	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	1.7	--	--	--	--	--	--	--	<1	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	1.2	--	--	--	--	--	<1	--	--	--	--	--	--	--
Lead	1.1	--	3.0	--	--	--	--	--	--	--	<1	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	1.4	--	4.9	1.8	--	--	--	--	--	--	1.3	<1	--	--
Selenium	3.9	1.4	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	14.4	2.9	4.3	--	1.3	--	<1	--	<1	--	<1	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	<1	--	--	--
Inorganics - Other Inorganics														
Cyanide	3.4	--	9.1	--	--	--	<1	--	<1	--	--	--	--	--
Fluoride	2.2	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	119.7	12.0	54.5	5.5	11.3	--	<1	--	--	--	15.5	1.5	--	--
Total HMW PAHs	2835.7	283.6	1034.3	103.4	268.2	26.8	1.6	<1	<1	--	290.0	29.0	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	<1	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	<1	--	--	--
South Percolation Pond (Transitional, soil/sedime														

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
ent)												
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	1.4	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	3.5	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	1.1	--	--	--	--	--	20.3	2.3
Selenium	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	--	--	--	--	5.1	--
Total HMW PAHs	<1	<1	4.3	--	230.5	3.7	--	--	<1	--	1438.8	23.0
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	1.8	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--
ent)												

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Inorganics - Metals														
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	**4.1**	**2.3**	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	**5.7**	--	<1	--	--	--	<1	--	--	--	<1	--	--	--
Lead	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**1.5**	--	--	--	--	--	<1	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	--	--	<1	--	--	--	<1	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	--	--	--	--	--	--	<1	--	--	--	<1	--	--	--
Total HMW PAHs	**1.4**	--	<1	<1	--	--	**1.5**	<1	--	--	**3.9**	<1	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	**2.6**	<1	--	--	--	--	--	--	**2.8**	<1	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	**2.3**	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--	**2.4**	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	**1.0**	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Cedar Creek Reservoir Overflow Ditch (Transitional, soil														
Inorganics - Metals														
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	1.8	--	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	11.0	1.3	--	--	<1	--	--	--	11.8	1.4	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	1.9	--	--	--	--	--	<1	--	<1	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	--	--	--	--	--	--	<1	--	<1	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	20.0	2.0	--	--	--	--	--	--	25.1	2.5	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	--	--	--	--	--	--	<1	--	--	--	1.3	--	--	--
Total HMW PAHs	2.3	--	9.4	<1	--	--	1.6	<1	<1	--	14.0	1.4	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	1.4	--	--	--	--	--	--	--	2.4	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	--	--	<1	--	--	--	--	--	--	--	1.3	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
	/sediment)											
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	**2.0**	--
Selenium	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (V												
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Northern Surface Water Feature (Transitional, soil/se														
Inorganics - Metals														
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	**3.8**	**2.1**	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	<1	--	--	<1	--	--	--	**2.4**	<1	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	<1	<1	--	--
Selenium	**3.5**	**1.2**	--	--	--	--	--	--	--	--	--	--	--	--
Silver	--	--	--	--	--	--	<1	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**1.7**	--	--	--	--	--	<1	--	<1	--	<1	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics														
Cyanide	--	--	--	--	--	--	<1	--	<1	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	<1	<1	--	--	--	--	--	--	**5.0**	<1	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	--	--	--	--	--	--	<1	--	--	--	<1	--	--	--
Total HMW PAHs	--	--	<1	--	--	--	**1.6**	<1	<1	--	**4.5**	<1	<1	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	<1	--	--	--	--	--	--	--	<1	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans														
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	<1	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
	diment)											
Inorganics - Metals												
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--
Barium	--	--	--	--	--	--	--	--	--	--	--	--
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	--	--	--	--	--	--	--	--	--	--
Lead	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	--	--	--	--	--	--	--	--	--	--	**1.3**	--
Silver	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	--	--	--	--	--	--	--	--	--	--	--	--
Inorganics - Other Inorganics												
Cyanide	--	--	--	--	--	--	--	--	--	--	--	--
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	<1	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	--	--	--	--	--	--	--	--	--	--	--	--
Total HMW PAHs	<1	<1	--	--	--	--	--	--	<1	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (V(												
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans												
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Flathead River Area (Surface Water/Sediment)														
Inorganics - Metals														
Aluminum	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Antimony	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Arsenic	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Barium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Beryllium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Cadmium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Chromium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Cobalt	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Copper	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Lead	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Manganese	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Mercury	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Nickel	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Selenium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Silver	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Thallium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Vanadium	**2.0**	--	NE	NE	**1.5**	--	NE	NE	NE	NE	NE	NE	NE	NE
Zinc	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Inorganics - Other Inorganics														
Cyanide	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Fluoride	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor 1254	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Total HMW PAHs	**1.4**	--	NE	NE	**1.6**	--	NE	NE	NE	NE	NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
2-Chloronaphthalene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Biphenyl (Diphenyl)	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Butylbenzylphthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Dibenzofuran	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Di-n-butyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Di-n-octyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Hexachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Hexachlorobutadiene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Hexachloroethane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Pentachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Dioxin/Furans														
Total Dioxins/Furans	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics - Metals												
Aluminum	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Antimony	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Arsenic	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Barium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Beryllium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cadmium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Chromium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cobalt	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Copper	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Lead	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Manganese	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Mercury	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Nickel	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Selenium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Silver	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Thallium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Vanadium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Zinc	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Inorganics - Other Inorganics												
Cyanide	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Fluoride	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Aroclor 1254	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Total HMW PAHs	NE	NE	NE	NE	NE	NE	**1.5**	--	NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2-Chloronaphthalene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Biphenyl (Diphenyl)	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Butylbenzylphthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dibenzofuran	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-butyl phthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-octyl phthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobenzene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobutadiene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachloroethane	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Pentachlorophenol	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Volatile Organic Compounds (V												
Methylcyclohexane	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dioxin/Furans												
Total Dioxins/Furans	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Yellow-Billed Cuckoo		Canada Lynx	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Cedar Creek Area (Surface Water/Sediment)														
Inorganics - Metals														
Aluminum	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Antimony	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Arsenic	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Barium	**1.1**	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Beryllium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Cadmium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Chromium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Cobalt	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Copper	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Lead	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Manganese	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Mercury	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Nickel	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Selenium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Silver	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Thallium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Vanadium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Zinc	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Inorganics - Other Inorganics														
Cyanide	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Fluoride	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)														
Aroclor 1248	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Aroclor 1254	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)														
Total LMW PAHs	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Total HMW PAHs	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs														
1,2,4,5-Tetrachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
2-Chloronaphthalene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Biphenyl (Diphenyl)	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Butylbenzylphthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Dibenzofuran	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Di-n-butyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Di-n-octyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Hexachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Hexachlorobutadiene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Hexachloroethane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Pentachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Volatile Organic Compounds (VOCs)														
Methylcyclohexane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE
Dioxin/Furans														
Total Dioxins/Furans	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE

Table 6-58
Summary of Area-Weighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		North American Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Inorganics - Metals												
Aluminum	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Antimony	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Arsenic	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Barium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Beryllium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cadmium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Chromium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cobalt	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Copper	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Lead	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Manganese	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Mercury	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Nickel	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Selenium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Silver	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Thallium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Vanadium	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Zinc	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Inorganics - Other Inorganics												
Cyanide	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Fluoride	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)												
Aroclor 1248	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Aroclor 1254	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)												
Total LMW PAHs	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Total HMW PAHs	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs												
1,2,4,5-Tetrachlorobenzene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2-Chloronaphthalene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Biphenyl (Diphenyl)	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Butylbenzylphthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dibenzofuran	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-butyl phthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-octyl phthalate	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobenzene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobutadiene	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachloroethane	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Pentachlorophenol	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Volatile Organic Compounds (V												
Methylcyclohexane	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dioxin/Furans												
Total Dioxins/Furans	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE

Notes:

--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
LOAEL: Lowest Observed Adverse Effects Level
NE: Receptor was not evaluated for the exposure area
NOAEL: No Observed Adverse Effects Level
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Shading key:
- [grey] = indicates LOAEL results for endangered species, which are evaluated based on their NOAEL results only.
- [yellow] = HQ greater than 1, less than 10
- [orange] = HQ greater than 10, less than 100
- [purple] = HQ greater than 100

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Main Plant Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Arsenic	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Barium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cadmium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Chromium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cobalt	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Copper	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Lead	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Manganese	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Mercury	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Nickel	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**1.1**	<1
Selenium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Vanadium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Zinc	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Fluoride	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	**1.0**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Total HMW PAHs	NE	NE	**13.9**	**1.4**	NE	NE	**2.5**	<1	<1	<1	**19.7**	**2.0**	<1	<1	**2.2**	<1	<1	<1	**3.6**	<1	NE	NE	<1	<1	**22.8**	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	**2.8**	<1	NE	NE	<1	<1	<1	<1	**4.2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	**1.8**	<1	NE	NE	<1	<1	<1	<1	**2.7**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**3.4**	<1

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Central Landfills Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Arsenic	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Barium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cadmium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Chromium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cobalt	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Copper	NE	NE	**11.3**	**1.3**	NE	NE	**2.1**	<1	<1	<1	**14.5**	**1.7**	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**2.4**	<1
Lead	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Manganese	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Mercury	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Nickel	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**3.7**	<1
Selenium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Vanadium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Zinc	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Fluoride	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	NE	NE	**20.7**	**2.1**	NE	NE	<1	<1	<1	<1	**30.9**	**3.1**	<1	<1	**1.7**	<1	<1	<1	<1	<1	NE	NE	<1	<1	**5.9**	<1
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	**1.4**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Total HMW PAHs	NE	NE	**9.7**	<1	NE	NE	**1.6**	<1	<1	<1	**13.8**	**1.4**	<1	<1	**1.5**	<1	<1	<1	**5.0**	<1	NE	NE	<1	<1	**33.4**	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	**1.5**	<1	NE	NE	<1	<1	<1	<1	**2.2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	**1.1**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**2.9**	<1

EHS Support

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Industrial Landfills Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**6.6**	<1
Arsenic	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Barium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cadmium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**1.6**	<1
Chromium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cobalt	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Copper	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	**1.0**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**6.7**	<1
Lead	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Manganese	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Mercury	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Nickel	NE	NE	**5.7**	**2.1**	NE	NE	<1	<1	<1	<1	**7.7**	**2.8**	<1	<1	<1	<1	<1	<1	**1.4**	<1	NE	NE	<1	<1	**28.1**	**3.2**
Selenium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Vanadium	NE	NE	**5.9**	**1.2**	NE	NE	**3.7**	<1	**1.4**	<1	**3.0**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Zinc	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Fluoride	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	**1.9**	<1	NE	NE	<1	<1	<1	<1	**2.7**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Total HMW PAHs	NE	NE	**35.4**	**3.5**	NE	NE	**7.1**	<1	<1	<1	**50.1**	**5.0**	<1	<1	**6.0**	<1	<1	<1	**6.9**	<1	NE	NE	<1	<1	**38.2**	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Eastern Undeveloped Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Arsenic	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Barium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cadmium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Chromium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cobalt	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Copper	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Lead	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Manganese	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Mercury	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Nickel	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	**1.0**	<1
Selenium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Vanadium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Zinc	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Fluoride	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Total HMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	**1.2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
North-Central Undeveloped Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Arsenic	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Barium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cadmium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Chromium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cobalt	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Copper	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Lead	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Manganese	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Mercury	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Nickel	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Selenium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Vanadium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Zinc	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Fluoride	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Total HMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Western Undeveloped Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Arsenic	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Barium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cadmium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Chromium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cobalt	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Copper	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Lead	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Manganese	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Mercury	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Nickel	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Selenium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Vanadium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Zinc	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Fluoride	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Total HMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	1.1	<1

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Flathead River Riparian Area (Soil)																										
Inorganics - Metals																										
Aluminum	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Antimony	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Arsenic	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Barium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Beryllium	NE	NE	--	--	NE	NE	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cadmium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Chromium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Cobalt	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Copper	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Lead	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Manganese	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Mercury	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Nickel	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Selenium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Silver	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Thallium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Vanadium	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Zinc	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Fluoride	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Aroclor 1254	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Total HMW PAHs	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2,3,4,6-Tetrachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
2-Chloronaphthalene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Biphenyl (Diphenyl)	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Bis(2-ethylhexyl)phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Butylbenzylphthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dibenzofuran	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Di-n-butyl phthalate	NE	NE	<1	<1	NE	NE	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	NE	NE	<1	<1	<1	<1
Di-n-octyl phthalate	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobenzene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachlorobutadiene	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Hexachloroethane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Pentachlorophenol	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	NE	NE	--	--	NE	NE	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NE	NE	--	--	--	--

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
North Percolation Pond (Transitional, soil/sediment)																										
Inorganics - Metals																										
Aluminum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	1.4	<1
Arsenic	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Barium	1.6	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cadmium	<1	<1	1.7	<1	<1	<1	<1	<1	<1	<1	2.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	3.5	<1
Chromium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Cobalt	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Copper	1.2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Lead	1.1	<1	3.0	<1	<1	<1	<1	<1	<1	<1	3.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Manganese	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Mercury	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Nickel	1.4	<1	4.9	1.8	<1	<1	<1	<1	<1	<1	6.6	2.4	<1	<1	<1	<1	<1	<1	1.1	<1	<1	<1	<1	<1	20.3	2.3
Selenium	3.9	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Silver	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Vanadium	14.4	2.9	4.3	<1	1.3	<1	2.7	<1	1.0	<1	2.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	3.4	<1	9.1	<1	<1	<1	8.0	<1	2.2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluoride	2.2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	119.7	12.0	54.5	5.5	11.3	<1	9.9	<1	<1	<1	78.1	7.8	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	5.1	<1
Total HMW PAHs	2835.7	283.6	1034.3	103.4	268.2	26.8	200.9	20.1	9.6	<1	1465.0	146.5	12.8	<1	172.8	2.8	4.3	<1	230.5	3.7	<1	<1	4.3	<1	1438.8	23.0
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	<1	<1	--	--	<1	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	1.8	<1
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent / HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
South Percolation Pond (Transitional, soil/sediment)																										
Inorganics - Metals																										
Aluminum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barium	4.1	2.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	1.3	<1	--	--	<1	<1	<1	<1	1.8	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	2.3	<1
Chromium	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Copper	5.7	<1	3.2	<1	<1	<1	<1	<1	<1	<1	4.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.4	<1
Lead	<1	<1	1.1	<1	<1	<1	<1	<1	<1	<1	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Manganese	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mercury	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Nickel	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	1.0	<1
Selenium	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Silver	--	--	<1	<1	--	--	1.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	1.5	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	<1	<1	1.1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	<1	<1	--	--	<1	<1	<1	<1	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Total HMW PAHs	1.4	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	11.5	1.2	--	--	<1	<1	<1	<1	17.2	1.7	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent / HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Cedar Creek Reservoir Overflow Ditch (Transitional, soil/sediment)																										
Inorganics - Metals																										
Aluminum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Barium	**1.8**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Lead	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Manganese	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	**2.0**	<1
Selenium	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Silver	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**1.9**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Inorganics - Other Inorganics																										
Cyanide	<1	<1	<1	<1	--	--	<1	<1	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	<1	<1	--	--	<1	<1	<1	<1	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Total HMW PAHs	**2.3**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																										
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent / HQ Criteria	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Northern Surface Water Feature (Transitional, soil/sediment)																												
Inorganics - Metals																												
Aluminum	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Antimony	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1	<1	<1
Barium	**3.8**	**2.1**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cadmium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Chromium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Cobalt	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Copper	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1	<1	<1
Lead	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1	<1	<1
Manganese	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Mercury	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Selenium	**3.5**	**1.2**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	**1.3**	<1
Silver	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	**1.7**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Zinc	--	--	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1	<1	<1
Inorganics - Other Inorganics																												
Cyanide	<1	<1	<1	<1	--	--	<1	<1	<1	<1	--	--	<1	<1	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1	<1	<1
Fluoride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polychlorinated Biphenyls (PCBs)																												
Aroclor 1248	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1254	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Polycyclic Aromatic Hydrocarbons (PAHs)																												
Total LMW PAHs	<1	<1	--	--	<1	<1	<1	<1	--	--	--	--	--	--	<1	<1	<1	<1	<1	<1	--	--	<1	<1	<1	<1
Total HMW PAHs	<1	<1	--	--	<1	<1	--	--	--	--	--	--	--	--	<1	<1	--	--	--	--	--	--	--	--	--	--
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																												
1,2,4,5-Tetrachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2,3,4,6-Tetrachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Chloronaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Biphenyl (Diphenyl)	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Butylbenzylphthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Di-n-octyl phthalate	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachlorobutadiene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Hexachloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pentachlorophenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Volatile Organic Compounds (VOCs)																												
Methylcyclohexane	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Dioxin/Furans																												
Total Dioxins/Furans	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

EHS Support

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Flathead River Area (Surface Water/Sediment)																										
Inorganics - Metals																										
Aluminum	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Antimony	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Arsenic	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Barium	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Beryllium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cadmium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Chromium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cobalt	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Copper	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Lead	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Manganese	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Mercury	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Nickel	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Selenium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Silver	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Thallium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Vanadium	**2.0**	<1	NE	NE	**1.5**	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Zinc	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Inorganics - Other Inorganics																										
Cyanide	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Fluoride	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)																										
Aroclor 1248	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Aroclor 1254	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)																										
Total LMW PAHs	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Total HMW PAHs	**1.4**	<1	NE	NE	**1.6**	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	**1.5**	<1	NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																										
1,2,4,5-Tetrachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2-Chloronaphthalene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Biphenyl (Diphenyl)	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Butylbenzylphthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dibenzofuran	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-butyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-octyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobutadiene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachloroethane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Pentachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Volatile Organic Compounds (VOCs)																										
Methylcyclohexane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dioxin/Furans																										
Total Dioxins/Furans	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE

Table 6-59
Summary of Unweighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Receptor	American Dipper		American Woodcock		Belted Kingfisher		Mourning Dove		Red-Tailed Hawk		Cuckoo		Canada Lynx		Grizzly Bear		Long-tailed Weasel		Meadow Vole		Mink		Wolverine		Short-tailed Shrew	
Constituent HQ Criteria	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**	**NOAEL**	**LOAEL**
Cedar Creek Area (Surface Water/Sediment)																												
Inorganics - Metals																												
Aluminum	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Antimony	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Arsenic	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Barium	1.1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Beryllium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cadmium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Chromium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Cobalt	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Copper	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Lead	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Manganese	<1	<1	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Mercury	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Nickel	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Selenium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Silver	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Thallium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Vanadium	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Zinc	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Inorganics - Other Inorganics																												
Cyanide	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Fluoride	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polychlorinated Biphenyls (PCBs)																												
Aroclor 1248	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Aroclor 1254	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Polycyclic Aromatic Hydrocarbons (PAHs)																												
Total LMW PAHs	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Total HMW PAHs	<1	<1	NE	NE	<1	<1	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	<1	<1	NE	NE	NE	NE
Semi-volatile Organic Compounds (SVOCs) - Non-PAH SVOCs																												
1,2,4,5-Tetrachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2,3,4,6-Tetrachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
2-Chloronaphthalene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Biphenyl (Diphenyl)	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Bis(2-ethylhexyl)phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Butylbenzylphthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dibenzofuran	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-butyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Di-n-octyl phthalate	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobenzene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachlorobutadiene	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Hexachloroethane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Pentachlorophenol	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Volatile Organic Compounds (VOCs)																												
Methylcyclohexane	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE
Dioxin/Furans																												
Total Dioxins/Furans	--	--	NE	NE	--	--	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	--	--	NE	NE	NE	NE

EHS Support

Table 6-59
Summary of Area-UnWeighted Wildlife Hazard Quotients Calculated using Refined EPCs
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Notes:
--, HQ is negligible. Chemical was either not a COPEC, or had minimal HQs (i.e., <1) for all relevant exposure areas. Full ingestion model results are presented in Appendix H2.
HMW, High molecular weight
HQ, Hazard quotient
$HQ_{LOAEL,}$ Hazard quotient calculated using the lowest-observable-adverse-effect toxicity reference value.
$HQ_{NOAEL,}$ Hazard quotient calculated using the no-observable-adverse-effect toxicity reference value.
LMW, Low molecular weight
LOAEL: Lowest Observed Adverse Effects Level
NE: Receptor was not evaluated for the exposure area
NOAEL: No Observed Adverse Effects Level
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
VOC, Volatile Organic Compound

Shading key:		
	(grey)	= indicates LOAEL results for endangered species, which are evaluated based on their NOAEL results only.
	(yellow)	= HQ greater than 1, less than 10
	(orange)	= HQ greater than 10, less than 100
	(purple)	= HQ greater than 100

Table 6-60
Effect of Flathead River Areas and Discharge (Q) on
Fluoride, Cyanide, Aluminum, and Barium Surface Water Concentrations
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Term	*df*	*SS*	*MS*	Statistic	*p* Value
Fluoride One-Way ANOVA - Downstream Portion of Flathead River					
Q Percentile	4	207,969	51,992	5.1	***0.004***
Residuals	22	222,525	10,115	NA	NA
Fluoride One-Way ANOVA - Backwater Area of Flathead River					
Q Percentile	6	12,975,755	2,162,626	4.1	***0.010***
Residuals	17	8,955,814	526,813	NA	NA
Fluoride One-Way ANOVA - Riparian Area of Flathead River					
Q Percentile	2	849,720	424,860	1.8	0.213
Residuals	12	2,886,240	240,520	NA	NA
Fluoride Two-Way ANOVA					
Area	2	49,805,550	24,902,775	105.3	***0.000***
Q Percentile	7	9,594,178	1,370,597	5.8	***0.000***
Area*Q Percentile	5	4,439,266	887,853	3.8	***0.006***
Residuals	51	12,064,579	236,560	NA	NA
Cyanide (Total) One-Way ANOVA - Downstream Portion of Flathead River					
Q Percentile	4	1,503	376	4.8	***0.005***
Residuals	25	1,954	78	NA	NA
Cyanide (Total) One-Way ANOVA - Backwater Area of Flathead River					
Q Percentile	6	210,462	35,077	3.7	***0.012***
Residuals	20	188,485	9,424	NA	NA
Cyanide (Total) One-Way ANOVA - Riparian Area of Flathead River					
Q Percentile	2	332,815	166,407	17.8	***0.000***
Residuals	17	159,201	9,365	NA	NA
Cyanide (Total) Two-Way ANOVA					
Area	2	337,607	168,804	29.9	***0.000***
Q Percentile	7	254,729	36,390	6.5	***0.000***
Area*Q Percentile	5	290,052	58,010	10.3	***0.000***
Residuals	62	349,641	5,639	NA	NA
Unfiltered Aluminum One-Way ANOVA - Downstream Portion of Flathead River					
Q Percentile	4	275,869	68,967	1.0	0.416
Residuals	20	1,337,574	66,879	NA	NA
Unfiltered Aluminum One-Way ANOVA - Backwater Area of Flathead River					
Q Percentile	6	927,948	154,658	1.6	0.217
Residuals	14	1,345,890	96,135	NA	NA
Unfiltered Aluminum One-Way ANOVA - Riparian Area of Flathead River					
Q Percentile	2	311,319,667	155,659,834	2.7	0.107
Residuals	12	688,059,460	57,338,288	NA	NA
Unfiltered Aluminum Two-Way ANOVA					
Area	2	121,627,291	60,813,645	4.0	***0.024***
Q Percentile	7	161,012,235	23,001,748	1.5	0.181
Area*Q Percentile	5	151,511,249	30,302,250	2.0	0.094
Residuals	46	690,742,925	15,016,151	NA	NA
Filtered Aluminum One-Way ANOVA - Downstream Portion of Flathead River					
Q Percentile	3	92.8	30.9	0.1	0.956
Residuals	15	4,456.9	297.1	NA	NA

Table 6-60
Effect of Flathead River Areas and Discharge (Q) on
Fluoride, Cyanide, Aluminum, and Barium Surface Water Concentrations
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Term	*df*	*SS*	*MS*	Statistic	*p* Value
Filtered Aluminum One-Way ANOVA - Backwater Area of Flathead River					
Q Percentile	3	84.6	28.2	0.5	0.665
Residuals	8	413.3	51.7	NA	NA
Filtered Aluminum One-Way ANOVA - Riparian Area of Flathead River					
Q Percentile	2	195,670	97,835	2.2	0.158
Residuals	12	543,843	45,320	NA	NA
Filtered Aluminum Two-Way ANOVA					
Area	2	271,883	135,941	8.7	***0.001***
Q Percentile	4	100,798	25,200	1.6	0.194
Area*Q Percentile	4	95,049	23,762	1.5	0.219
Residuals	35	548,713	15,678	NA	NA
Unfiltered Barium One-Way ANOVA - Downstream Portion of Flathead River					
Q Percentile	4	6,636	1,659	14.9	***0.000***
Residuals	20	2,221	111	NA	NA
Unfiltered Barium One-Way ANOVA - Backwater Area of Flathead River					
Q Percentile	6	27,564	4,594	6.2	***0.002***
Residuals	14	10,316	737	NA	NA
Unfiltered Barium One-Way ANOVA - Riparian Area of Flathead River					
Q Percentile	2	306,036	153,018	2.7	0.109
Residuals	12	684,548	57,046	NA	NA
Unfiltered Barium Two-Way ANOVA					
Area	2	518,216	259,108	17.1	***0.000***
Q Percentile	7	212,396	30,342	2.0	0.075
Area*Q Percentile	5	127,840	25,568	1.7	0.157
Residuals	46	697,086	15,154	NA	NA
Filtered Barium One-Way ANOVA - Downstream Portion of Flathead River					
Q Percentile	3	9,093	3,031	41.5	***0.000***
Residuals	15	1,095	73	NA	NA
Filtered Barium One-Way ANOVA - Backwater Area of Flathead River					
Q Percentile	3	19,849	6,616	11.0	***0.003***
Residuals	8	4,814	602	NA	NA
Filtered Barium One-Way ANOVA - Riparian Area of Flathead River					
Q Percentile	2	15,236	7,618	1.2	0.337
Residuals	12	76,638	6,386	NA	NA
Filtered Barium Two-Way ANOVA					
Area	2	168,507	84,253	35.7	***0.000***
Q Percentile	4	38,403	9,601	4.1	***0.008***
Area*Q Percentile	4	5,775	1,444	0.6	0.657
Residuals	35	82,546	2,358	NA	NA

Notes:
ANOVA - Analysis of variance
df - Degrees of freedom
SS - Sum of squares error
MS - Mean squares error

Table 6-61
Summary of Whole Effluent Toxicity (WET) Testing Results in the Backwater Seeps Sampling Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Test Organism	Test Duration	Dilution (% of Effluent)	Percent Survival of Test Organisms																	
			2014	2015				2016				2017				2018				2019
			Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Daphnid (*Ceriodaphnia dubia*)	48 hours	0%	95	100	100	95	95	100	95	90	100	95	100	100	100	100	100	100	100	100
		6.25%	95	90	100	95	100	100	100	100	100	95	95	100	100	100	100	100	100	100
		12.5%	100	100	100	100	95	95	100	100	100	100	100	95	95	100	100	100	100	100
		25%	100	95	100	100	95	100	100	100	100	90	95	95	95	100	100	100	100	100
		50%	95	90	95	95	95	95	100	95	95	90	85	100	100	95	100	100	100	100
		100%	100	80	85	90	85	80	100	85	95	100	95	90	95	75	100	90	100	100
Fathead minnow (*Pimephales promelas*)	96 hours	0%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	95
		6.25%	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
		12.5%	100	100	95	100	100	95	100	100	100	100	100	100	100	100	100	100	100	100
		25%	100	100	100	100	100	95	100	100	100	100	100	100	100	100	100	100	100	100
		50%	100	100	100	100	100	85	100	100	100	100	100	100	100	95	100	100	100	100
		100%	100	100	100	100	100	80	100	100	100	100	100	100	100	100	100	100	100	100

Table 6-62
Results of One-Way ANOVA Between Percent Effluent and Percent Survival
in WET Testing in the Backwater Seep Sampling Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Table 6-61a. Results of One-Way Analysis of Variance of the Effect of Percent Effluent on Test Organism Survival

Factor	Sum of Squares	DF	F Statistic	p-value
Daphnid (*Ceriodaphnia dubia*)				
Percent Effluent	721	5	7.38	***<0.001***
Residuals	1994	102	--	--
Fathead minnow (*Pimephales promelas*)				
Percent Effluent	19.4	5	0.57	0.72
Residuals	697	102	--	--

Notes:
Response variable was percent survival of the test organism
-- Not applicable
DF - Degrees of Freedom

Table 6-61b. P-values from post hoc Tukey's Honestly Signficant Difference Test of the Effect of Percent Effluent on *Ceriodaphnia dubia*

Percent Effluent	0 (Control)	6.25	12.5	25	50	100
0 (Control)	---					
6.25	1	---				
12.5	1	1	---			
25	1	1	1	---		
50	0.7	0.5	0.3	0.7	---	
100	***<0.001***	***<0.001***	***<0.001***	***<0.001***	***<0.05***	---

Notes:
P-values indicating significant differences in mean survival (p<0.05) are presented in bold italics.

Table 6-61c. Difference in Mean Survival Between Effect of Percent Effluent on *Ceriodaphnia dubia*

Percent Effluent	0 (Control)	6.25	12.5	25	50	100
0 (Control)	---					
6.25	-0.3	---				
12.5	-0.8	-0.6	---			
25	0	0.3	0.8	---		
50	2.2	2.5	3.1	2.2	---	
100	***6.7***	***6.9***	***7.5***	***6.7***	***4.4***	---

Notes:
Significant differences in mean survival are presented in bold italics.

Table 7-1
Range of Exposure Point Concentration Estimates
Operational Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Mean EPC Estimates			Maximum EPC Estimates		
				Lower	Measured	Upper	Lower	Measured	Upper
TAL Metals (mg/kg)									
Aluminum	7429-90-5	86	86	19649	20499	21350	35935	37700	39465
Antimony	7440-36-0	86	75	0.379	0.588	0.796	6.19	8.60	11.0
Arsenic	7440-38-2	86	86	5.76	6.39	7.02	27.0	31.3	35.6
Barium	7440-39-3	86	86	141	150	159	281	302	330
Beryllium	7440-41-7	86	86	0.796	0.839	0.882	3.47	3.70	3.93
Cadmium	7440-43-9	86	86	0.257	0.291	0.325	1.36	1.60	1.84
Chromium, Total	7440-47-3	86	86	19.5	21.3	23.1	50.2	54.4	58.6
Chromium, Hexavalent	18540-29-9	86	86	0.522	0.571	0.619	1.34	1.46	1.57
Chromium, Trivalent	16065-83-1	86	86	19.0	20.7	22.5	48.8	52.9	57.0
Cobalt	7440-48-4	86	86	6.31	6.48	6.64	13.0	13.5	14.0
Copper	7440-50-8	86	86	57.9	63.7	69.5	778	887	996
Iron	7439-89-6	86	86	18386	18893	19400	64433	66700	68967
Lead	7439-92-1	86	86	24.0	35.2	46.5	253	406	603
Manganese	7439-96-5	86	86	465	494	522	902	902	902
Mercury	7439-97-6	86	60	0.018	0.028	0.037	0.140	0.140	0.140
Nickel	7440-02-0	86	86	26.9	30.1	33.4	121	142	163
Selenium	7782-49-2	86	86	1.21	1.48	1.74	10.6	13.3	16.0
Silver	7440-22-4	86	86	0.107	0.118	0.128	1.18	1.30	1.42
Thallium	7440-28-0	86	86	0.110	0.122	0.133	0.387	0.400	0.457
Vanadium	7440-62-2	86	86	17.8	19.0	20.1	52.3	54.5	59.5
Zinc	7440-66-6	86	86	103	114	125	1501	1720	1939
Other Inorganic Parameters (mg/kg unless otherwise noted)									
Cyanide	57-12-5	86	84	0.671	0.928	1.18	10.9	18.2	25.5
Fluoride	16984-48-8	86	86	212	272	333	781	976	1218
Essential Nutrients (mg/kg)									
Calcium	7440-70-2	86	86	16847	19082	21316	40825	45700	50575
Magnesium	7439-95-4	86	86	10374	10612	10849	13010	13300	13590
Potassium	7440-09-7	86	86	1379	1464	1549	3069	3080	3272
Sodium	7440-23-5	86	82	836	1084	1332	6298	9000	11767

Table 7-1
Range of Exposure Point Concentration Estimates
Operational Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Mean EPC Estimates			Maximum EPC Estimates		
				Lower	Measured	Upper	Lower	Measured	Upper
Pesticides (mg/kg)									
Aldrin	309-00-2	43	0	---	---	---	---	---	---
Alpha Bhc (Alpha Hexachlorocyclohexane)	319-84-6	43	0	---	---	---	---	---	---
Alpha Endosulfan	959-98-8	43	0	---	---	---	---	---	---
Beta Bhc (Beta Hexachlorocyclohexane)	319-85-7	43	0	---	---	---	---	---	---
Beta Endosulfan	33213-65-9	43	0	---	---	---	---	---	---
cis-Chlordane	5103-71-9	43	0	---	---	---	---	---	---
Delta BHC (Delta Hexachlorocyclohexane)	319-86-8	43	0	---	---	---	---	---	---
Dieldrin	60-57-1	43	0	---	---	---	---	---	---
Endosulfan Sulfate	1031-07-8	43	0	---	---	---	---	---	---
Endrin	72-20-8	43	0	---	---	---	---	---	---
Endrin Aldehyde	7421-93-4	43	0	---	---	---	---	---	---
Endrin Ketone	53494-70-5	43	0	---	---	---	---	---	---
Gamma Bhc (Lindane)	58-89-9	43	0	---	---	---	---	---	---
Heptachlor	76-44-8	43	0	---	---	---	---	---	---
Heptachlor Epoxide	1024-57-3	43	0	---	---	---	---	---	---
Methoxychlor	72-43-5	43	0	---	---	---	---	---	---
P,P'-DDD	72-54-8	43	0	---	---	---	---	---	---
P,P'-DDE	72-55-9	43	0	---	---	---	---	---	---
P,P'-DDT	50-29-3	43	0	---	---	---	---	---	---
Toxaphene	8001-35-2	43	0	---	---	---	---	---	---
trans-Chlordane	5103-74-2	43	0	---	---	---	---	---	---
Polychlorinated Biphenyls (PCBs) (mg/kg)									
PCB-1016 (Aroclor 1016)	12674-11-2	86	0	---	---	---	---	---	---
PCB-1221 (Aroclor 1221)	11104-28-2	86	0	---	---	---	---	---	---
PCB-1232 (Aroclor 1232)	11141-16-5	86	0	---	---	---	---	---	---
PCB-1242 (Aroclor 1242)	53469-21-9	86	0	---	---	---	---	---	---
PCB-1248 (Aroclor 1248)[1]	12672-29-6	86	1	0.200	0.200	0.200	0.200	0.200	0.200
PCB-1254 (Aroclor 1254)	11097-69-1	86	14	0.194	0.310	0.426	1.73	1.73	1.73
PCB-1260 (Aroclor 1260)	11096-82-5	86	0	---	---	---	---	---	---
PCB-1262 (Aroclor 1262)	37324-23-5	86	0	---	---	---	---	---	---
PCB-1268 (Aroclor 1268)	11100-14-4	86	0	---	---	---	---	---	---
Polychlorinated Biphenyl (PCBs)	1336-36-3	86	15	0.176	0.303	0.430	1.73	1.73	1.73

Table 7-1
Range of Exposure Point Concentration Estimates
Operational Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Mean EPC Estimates			Maximum EPC Estimates		
				Lower	Measured	Upper	Lower	Measured	Upper
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)									
2-Methylnaphthalene	91-57-6	86	72	0.373	0.706	1.04	14.1	27.0	39.9
Acenaphthene	83-32-9	86	84	0.897	2.78	4.66	22.0	110	199
Acenaphthylene	208-96-8	86	26	0.148	0.288	0.427	1.92	3.10	5.05
Anthracene	120-12-7	86	80	1.74	4.86	7.98	44.3	150	274
Fluoranthene	206-44-0	86	86	9.09	19.1	29.0	188	440	754
Fluorene	86-73-7	86	83	0.897	2.37	3.85	24.3	94.0	164
Naphthalene	91-20-3	86	76	1.05	1.55	2.05	48.4	68.0	87.6
Phenanthrene	85-01-8	86	86	6.94	16.3	25.6	186	450	801
Total LMW PAHs - 1/2MDL	---	86	86	20.4	46.9	73.3	474	1342	2339
Total LMW PAHs - MDL	---	86	86	20.4	46.9	73.3	475	1342	2339
Total LMW PAHs - Zero	---	86	86	20.4	46.8	73.3	474	1342	2339
Benzo(A)Pyrene	50-32-8	86	85	5.67	11.2	16.7	83.0	240	401
Benzo(A)Anthracene	56-55-3	86	84	5.79	11.1	16.4	95.1	240	405
Benzo(B)Fluoranthene	205-99-2	86	86	8.49	14.2	20.0	108	270	432
Benzo(G,H,I)Perylene	191-24-2	86	85	5.67	9.94	14.2	86.3	220	354
Benzo(K)Fluoranthene	207-08-9	86	85	2.98	5.45	7.92	46.1	130	214
Chrysene	218-01-9	86	86	7.17	12.9	18.6	103	250	407
Dibenz(A,H)Anthracene	53-70-3	86	82	1.41	2.70	3.98	18.4	51.0	83.6
Indeno(1,2,3-C,D)Pyrene	193-39-5	86	84	5.20	9.07	12.9	68.9	170	275
Pyrene	129-00-0	86	86	8.47	18.2	27.9	176	410	708
Total HMW PAHs - 1/2MDL	---	86	86	53.7	93.5	133	828	1981	3263
Total HMW PAHs - MDL	---	86	86	53.7	93.5	133	828	1981	3263
Total HMW PAHs - Zero	---	86	86	53.7	93.5	133	828	1981	3263
Total PAHs - 1/2MDL	---	86	86	65.9	126	185	1205	3026	5094
Total PAHs - MDL	---	86	86	65.9	126	185	1205	3026	5094
Total PAHs - Zero	---	86	86	65.8	126	185	1205	3026	5094
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)									
1,2,4,5-Tetrachlorobenzene	95-94-3	86	0	---	---	---	---	---	---
1,4-Dioxane (P-Dioxane)	123-91-1	86	0	---	---	---	---	---	---
2,3,4,6-Tetrachlorophenol	58-90-2	86	0	---	---	---	---	---	---
2,4,5-Trichlorophenol	95-95-4	86	0	---	---	---	---	---	---
2,4,6-Trichlorophenol	88-06-2	86	0	---	---	---	---	---	---
2,4-Dichlorophenol	120-83-2	86	0	---	---	---	---	---	---
2,4-Dimethylphenol[1]	105-67-9	86	2	0.480	0.480	0.480	0.710	0.710	0.710
2,4-Dinitrophenol	51-28-5	86	0	---	---	---	---	---	---
2,4-Dinitrotoluene	121-14-2	86	0	---	---	---	---	---	---
2,6-Dinitrotoluene	606-20-2	86	0	---	---	---	---	---	---
2-Chloronaphthalene	91-58-7	86	0	---	---	---	---	---	---
2-Chlorophenol	95-57-8	86	0	---	---	---	---	---	---
2-Methylphenol (O-Cresol)	95-48-7	86	0	---	---	---	---	---	---
2-Nitroaniline	88-74-4	86	0	---	---	---	---	---	---
2-Nitrophenol	88-75-5	86	0	---	---	---	---	---	---

Table 7-1
Range of Exposure Point Concentration Estimates
Operational Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Mean EPC Estimates			Maximum EPC Estimates		
				Lower	Measured	Upper	Lower	Measured	Upper
3- And 4- Methylphenol (Total)[1]	106445	62	2	0.014	0.014	0.014	0.017	0.017	0.017
3,3'-Dichlorobenzidine	91-94-1	86	0	---	---	---	---	---	---
3-Nitroaniline	99-09-2	86	0	---	---	---	---	---	---
4,6-Dinitro-2-Methylphenol	534-52-1	86	0	---	---	---	---	---	---
4-Bromophenyl Phenyl Ether	101-55-3	86	0	---	---	---	---	---	---
4-Chloro-3-Methylphenol	59-50-7	86	0	---	---	---	---	---	---
4-Chloroaniline	106-47-8	86	0	---	---	---	---	---	---
4-Chlorophenyl Phenyl Ether	7005-72-3	86	0	---	---	---	---	---	---
4-Nitroaniline	100-01-6	86	0	---	---	---	---	---	---
4-Nitrophenol	100-02-7	86	0	---	---	---	---	---	---
Acetophenone	98-86-2	86	21	0.009	0.015	0.021	0.017	0.030	0.043
Atrazine	1912-24-9	86	0	---	---	---	---	---	---
Benzaldehyde[1]	100-52-7	86	8	0.026	0.026	0.026	0.051	0.051	0.051
Benzyl Butyl Phthalate	85-68-7	86	16	0.227	0.230	0.233	1.40	1.40	1.40
Biphenyl (Diphenyl)	92-52-4	86	20	0.089	0.632	1.18	1.06	7.10	14.1
Bis(2-Chloroethoxy) Methane	111-91-1	86	0	---	---	---	---	---	---
Bis(2-Chloroethyl) Ether (2-Chloroethyl Ether)	111-44-4	86	0	---	---	---	---	---	---
Bis(2-Chloroisopropyl) Ether	108-60-1	86	0	---	---	---	---	---	---
Bis(2-Ethylhexyl) Phthalate[1]	117-81-7	86	16	0.115	0.115	0.115	0.810	0.810	0.810
Caprolactam	105-60-2	86	0	---	---	---	---	---	---
Carbazole	86-74-8	86	84	1.13	2.61	4.09	26.4	78.0	137
Dibenzofuran	132-64-9	86	78	0.584	1.44	2.30	16.5	55.0	93.5
Diethyl Phthalate[1]	84-66-2	86	2	0.015	0.015	0.015	0.015	0.015	0.015
Dimethyl Phthalate	131-11-3	86	0	---	---	---	---	---	---
Di-N-Butyl Phthalate[1]	84-74-2	86	22	0.025	0.025	0.025	0.067	0.067	0.067
Di-N-Octylphthalate	117-84-0	86	0	---	---	---	---	---	---
Hexachlorobenzene	118-74-1	86	0	---	---	---	---	---	---
Hexachlorobutadiene	87-68-3	86	0	---	---	---	---	---	---
Hexachlorocyclopentadiene	77-47-4	86	0	---	---	---	---	---	---
Hexachloroethane	67-72-1	86	0	---	---	---	---	---	---
Isophorone	78-59-1	86	13	0.041	0.048	0.055	0.099	0.110	0.146
Nitrobenzene	98-95-3	86	0	---	---	---	---	---	---
N-Nitrosodi-N-Propylamine	621-64-7	86	0	---	---	---	---	---	---
N-Nitrosodiphenylamine	86-30-6	86	0	---	---	---	---	---	---
Pentachlorophenol[1]	87-86-5	86	1	0.100	0.100	0.100	0.100	0.100	0.100
Phenol[1]	108-95-2	86	9	0.018	0.018	0.018	0.033	0.033	0.033

Table 7-1
Range of Exposure Point Concentration Estimates
Operational Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	CAS Number	Number of Samples	Number of Detections	Mean EPC Estimates			Maximum EPC Estimates		
				Lower	Measured	Upper	Lower	Measured	Upper
Physicochemical Parameters (mg/kg)									
Total Organic Carbon	7440440	24	23	13592	17340	21089	30142	38800	64145

Notes:
[1,] No RSD adjustment or UCL substitution due to no detected results in replicate samples. Measured results used instead.
---, Not applicable.
EPC, Exposure point concentration
HMW, High molecular weight
LMW, Low molecular weight
mg/kg, milligrams per kilogram
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
SVOC, Semi-Volatile Organic Compound
TAL, Target Analyte List
TCL, Target Compound List
TEC, Toxic Equivalency Concentration

Table 7-2
Comparison of Concentrations Between Incremental and Discrete Soil Samples
Operational Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Cas Number	Incremental Samples					Discrete Samples				
		Number of Samples	Number of Detections	Minimum Result	Mean Result	Maximum Result	Number of Samples	Number of Detections	Minimum Result	Mean Result	Maximum Result
Main Plant Area											
TAL Metals (mg/kg)											
Aluminum	7429-90-5	28	28	14600	20904	36200	10	10	6780	13363	31200
Antimony	7440-36-0	28	28	0.110	0.989	8.60	10	1	0.150	0.252	0.610
Arsenic	7440-38-2	28	28	4.10	7.36	31.3	10	10	2.70	4.77	7.60
Cadmium	7440-43-9	28	28	0.082	0.380	1.60	10	1	0.150	0.211	0.600
Chromium, Total	7440-47-3	28	28	12.9	20.5	36.8	12	12	7.50	18.4	80.8
Copper	7440-50-8	28	28	15.4	91.1	887	10	10	10.6	19.0	34.5
Lead	7439-92-1	28	28	10.3	34.2	144	10	10	7.80	16.2	31.5
Mercury	7439-97-6	28	12	0.007	0.017	0.058	10	9	0.005	0.017	0.030
Nickel	7440-02-0	28	28	13.4	28.1	62.8	10	10	10.0	21.5	75.0
Selenium	7782-49-2	28	28	0.730	1.33	2.60	10	2	0.150	0.241	0.460
Vanadium	7440-62-2	28	28	12.3	18.6	44.5	10	10	7.40	12.1	20.2
Zinc	7440-66-6	28	28	44.8	205	1720	10	10	31.2	56.1	96.1
Other Inorganic Parameters (mg/kg unless otherwise noted)											
Cyanide	57-12-5	28	28	0.021	0.348	1.20	10	10	0.048	0.165	0.620
Fluoride	16984-48-8	28	28	56.3	264	709	10	10	23.7	104	277
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)											
Total LMW PAHs - 1/2MDL	--	28	28	0.461	18.7	194	10	10	0.088	12.8	61.7
Total HMW PAHs - 1/2MDL	--	28	28	1.05	72.1	823	10	10	0.253	56.5	288
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Bis(2-Ethylhexyl) Phthalate	117-81-7	28	3	0.006	0.026	0.160	10	1	0.007	0.125	0.950
Diethyl Phthalate	84-66-2	28	0	0.005	0.015	0.115	10	0	0.005	0.036	0.265
Central Landfills Area											
TAL Metals (mg/kg)											
Arsenic	7440-38-2	58	58	4.20	5.72	12.3	36	36	3.70	5.42	9.00
Barium	7440-39-3	58	58	59.4	133	293	36	36	40.7	111	264
Beryllium	7440-41-7	58	58	0.400	0.847	3.70	36	36	0.270	0.548	1.50
Chromium, Total	7440-47-3	58	58	13.6	21.1	54.4	44	43	0.290	12.1	84.8
Copper	7440-50-8	58	58	14.1	49.9	721	36	36	8.80	16.2	60.0
Lead	7439-92-1	58	58	8.60	31.4	406	36	36	7.60	13.6	48.0
Manganese	7439-96-5	58	58	341	481	657	36	36	218	481	1050
Nickel	7440-02-0	58	58	12.3	29.9	142	36	36	7.40	18.0	80.5
Selenium	7782-49-2	58	58	0.180	1.46	13.3	36	7	0.120	0.274	1.20
Thallium	7440-28-0	58	58	0.060	0.117	0.400	36	10	0.050	0.088	0.150
Vanadium	7440-62-2	58	58	8.60	18.8	54.5	36	36	5.70	13.5	24.2
Zinc	7440-66-6	58	58	44.4	68.1	214	36	36	28.9	54.0	114
Other Inorganic Parameters (mg/kg unless otherwise noted)											
Cyanide	57-12-5	58	56	0.017	0.953	18.2	36	33	0.008	1.04	13.0
Fluoride	16984-48-8	58	58	16.6	268	976	36	36	9.45	118	796
Polychlorinated Biphenyls (PCBs) (mg/kg)											
PCB-1254 (Aroclor 1254)	11097-69-1	58	14	4.60E-05	0.070	1.30	42	6	0.005	0.072	1.20
Polycyclic Aromatic Hydrocarbons (PAHs) (mg/kg)											
Total LMW PAHs - 1/2MDL	--	58	58	0.068	59.2	1342	36	36	0.021	33.6	596
Total HMW PAHs - 1/2MDL	--	58	58	0.135	101	1981	36	36	0.048	50.3	789

Table 7-2
Comparison of Concentrations Between Incremental and Discrete Soil Samples
Operational Area
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Constituent	Cas Number	Incremental Samples					Discrete Samples				
		Number of Samples	Number of Detections	Minimum Result	Mean Result	Maximum Result	Number of Samples	Number of Detections	Minimum Result	Mean Result	Maximum Result
TCL Semi-Volatile Organic Compounds (TCL SVOCs) (mg/kg)											
Bis(2-Ethylhexyl) Phthalate	117-81-7	58	13	0.006	0.246	3.55	36	5	0.007	0.046	0.360
Dibenzofuran	132-64-9	58	53	0.005	1.85	55.0	36	20	8.00E-04	0.723	15.0
Di-N-Butyl Phthalate	84-74-2	58	10	0.005	0.096	1.45	36	2	0.005	0.027	0.275

Notes:
Constituents shown are chemicals of potential ecological concern for the two exposure areas.
Discrete sample data are for grab soil samples that occur within the incremental sample decision units that overlap the specific exposure area.
Incremental sample data represent the 95 percent upper confidence limit of the mean for decision units where triplicate samples were collected, or the measured (i.e., unadjusted) concentration for decision units lacking replication.
Half the quantitation limit substituted for non-detected results.
Shaded/bolded results indicate the mean of the incremental samples was greater than the mean of the discrete samples.
---, Not applicable.
HMW, High molecular weight
LMW, Low molecular weight
MDL, Method detection limit
mg/kg, milligrams per kilogram
PAH, Polycyclic Aromatic Hydrocarbon
PCB, Polychlorinated Biphenyl
PCE, Tetrachloroethylene
SVOC, Semi-Volatile Organic Compound
TAL, Target Analyte List
TCL, Target Compound List

Table 8-1
Summary of BERA Findings - Terrestrial Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	Direct Contact Exposure Summary			Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Soil Invertebrates	**Terrestrial Plant Community**	**Overall Direct Contact Risk**	**Birds**	**Mammals**	**Overall Wildlife Risk**	
Main Plant Area	Minimal Risk. Localized risk to soil invertebrates due to PAH exposure. Maximum EPCs > NOECs for LMW PAHs (HQ_{NOEC}=19) and HMW PAHs (HQ_{NOEC}=35.7). LOECs not identified for LMW and HMW PAHs. Refined EPCs > NOEC for LMW PAHs (HQ_{LOEC}=2.2) and HMW PAHs (HQ_{LOEC}=4.3). Negligible risk to other COPECs (maximum exposure < LOEC)	Negligible risk; maximum exposure < LOEC.	**Minimal**	**Maximum scenario:** Moderate Risk. Potential for adverse effects to birds exposed to HMW PAHs (HQ_{LOAEL}=11.5 to 16.3) and BEHP (HQ_{LOAEL}=3.0 to 4.5) if foraging exclusively at maximum EPC. **Refined scenario:** Moderate Risk.Limited potential for adverse effects to brids exposed to HMW PAHs (HQ_{LOAEL}=1.4 to 2.0)	**Maximum scenario:** Low potential for adverse effects for mammals foraging exclusively within the exposure area; maximum short-tailed shrew exposure HMW PAHs exceeds LOAEL (HQ_{NOAEL}=2.9); all other COPEC/receptors HQ_{LOAEL}<1. **Refined scenario:** Negligible risk foraging exclusively within the exposure area; Refined HQ_{LOAEL}<1. **Small Ranging Receptors:** Potential for adverse effects greatest for small mammals in northern portion of Main Plant within the Operational Area footprint; short-tailed shrew exposure > LOAEL at 5 of 90 stations and meadow vole exposure > LOAEL at 9 of 90 stations.	**Moderate**	Local impacts to soil invertebrate communities due to direct contact possible but localized. Possible impacts to birds foraging on terrestrial invertebrates (earthworms) in exposure area. Localized impacts to small-range mammalian receptors possible. Ecological expsure pathways limited under current, developed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.
Central Landfills Area	Negligible risk; Maximum EPCs < LOEC, except for copper (HQ_{LOEC}=13.7). Maximum EPCs > NOECs for LMW PAHs (HQ_{NOEC}=33) and HMW PAHs (HQ_{NOEC}=27). LOECs not identified for LMW and HMW PAHs. Refined EPC for copper (HQ_{LOEC}=1.4). Refined EPCs > NOEC for LMW PAHs (HQ_{LOEC}=3.0) and HMW PAHs (HQ_{LOEC}=3.0).	Negligible risk; maximum exposure < LOEC, except for copper; refined exposure estimate indicates slight exceedance of copper LOEC (HQ_{LOEC}=1.5).	**Minimal**	**Maximum scenario:** Moderate Risk. Potential for adverse effects to birds exposed to copper, nickel, LMW PAHs, HMW PAHs, Aroclor 1254 and BEHP (HQ_{LOAEL}=1.3 to 17.0) if foraging exclusively at maximum EPC. **Refined scenario:** Moderate Risk**.** Potential for adverse effects to birds exposed to copper, HMW PAHs, and Aroclor 1254 (HQ_{LOAEL}=1.3 to 3.1) if foraging exclusively at refined EPC.	**Maximum scenario:** Negligible Risk. Low potential for adverse effects for mammals foraging exclusively within the exposure area; maximum short-tailed shrew exposure exceeds LOAEL for copper, nickel, PCB1254, HMW PAHs and meadow vole for selenium (HQ_{NOAEL}=1.6 to 5.7); all other COPEC/receptors HQ_{LOAEL}<1. **Refined scenario:** Negligible risk foraging exclusively within the exposure area; Refined HQ_{LOAEL}<1. **Small Ranging Receptors:** Minimal Risk. Potential for adverse effects greatest for small mammals in northern portion of Main Plant within the Operational Area footprint; short tailed shrew exposure > LOAEL at 6 of 67 stations and meadow vole exposure < LOAEL.	**Moderate**	Possible impacts to birds foraging on terrestrial invertebrates (earthworms) in exposure area. Localized impacts to small-range mammalian receptors possible. Ecological expsure pathways limited under current, disturbed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.
Industrial Landfill Area	Minimal Risk. Limited risk due to PAH exposure. Maximum EPCs < LOECs for metals; maximum EPCs > NOECs for LMW PAHs (HQ_{NOE}C=7.0) and HMW PAHs (HQ_{NOEC}=13.4); LOECs not identified for LMW and HMW PAHs. Refined EPCs < LOECs for metals; refined EPCs > NOECs for for LMW PAHs (HQ_{NOEC}=6.5) and HMW PAHs (HQ_{NOEC}=12.9).	Negligible risk. Maximum EPCs < LOEC, except for slight exceedances of nickel (HQ_{LOEC}=1.7) and vanadium (HQ_{LOEC}=2.1). Refined exposure estimate indicates slight exceedances of LOECs for nickel (HQ_{LOEC}=1.5) and vanadium (HQ_{LOEC}=1.9).	**Minimal**	**Maximum scenario:** Moderate Risk. Potential for adverse effects to birds exposed to nickel and HMW PAHs (HQ_{LOAEL}=1.3 to 5.2) if foraging at maximum exposure exclusively within the Industrial Landfill Area. **Refined scenario:** Moderate Risk. Limited potential for adverse effects to birds exposued to refined EPCs for nickel and HMW PAHs (HQ_{LOAEL}=2.1 to 5.0).	**Maximum scenario:** Moderate Risk. nickel, vanadium, and HMW PAHs had HQ_{NOAEL} and HQ_{LOAEL} values greater than 1. **Refined scenario:** Moderate Risk. Nickel has HQ_{LOAEL} value > 1, but below 5. **Small Ranging Receptors:** Moderate risk. Two of the 6 sample locations exceeded the LOAEL benchmarks for the short-tailed shrew (nickel and PAHs).	**Moderate**	Possible impacts to birds foraging on terrestrial invertebrates (earthworms) in exposure area. Localized impacts to small-range mammalian receptors possible. Ecological expsure pathways limited under current, disturbed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

Table 8-1
Summary of BERA Findings - Terrestrial Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	**Direct Contact Exposure Summary**			**Wildlife Exposure Summary**			**Preliminary Conclusions and Recommendations**
	Soil Invertebrates	**Terrestrial Plant Community**	**Overall Direct Contact Risk**	**Birds**	**Mammals**	**Overall Wildlife Risk**	
Eastern Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk. Maximum EPCs < LOEC, except for barium (HQ$_{LOEC}$=4.1) and manganese (HQ$_{LOEC}$=3.6). Refined EPCs slightly exceed LOECs for barium (HQ$_{LOEC}$=2.2) and manganese (HQ$_{LOEC}$=1.3). Manganese comparable to background.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ$_{LOAEL}$<1; maximum cyanide HQ$_{NOAEL}$=1.0-1.4 (lead, nickel, vanadium, zinc, cyanide, and bis(2-ethylhexyl)phthalate) **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ$_{LOAEL}$<1; refined EPCs < NOAEL, except for BEHP expsoure to yellow-billed cuckoo (HQ$_{NOAEL}$=1.2).	**Maximum scenario:** Negligible risk foraging exclusively within the exposure area; maximum short tailed short-tailed shrew exposure to nickel (HQ$_{NOAEL}$=1.7); other COPEC/receptors HQ$_{NOAEL}$<1 **Refined scenario:** Negligible risk foraging exclusively within the exposure area; Refined HQ$_{LOAEL}$<1; refined EPCs < NOAEL, except for nickel exposure to short-tailed shrew (HQ$_{NOAEL}$=1.0). **Small Ranging Receptors:** Negligible risk; < NOAEL for meadow vole for all constituents at 21 of 22 stations and < NOAEL for short-tailed shrew at 10 of 21 stations (max nickel HQ$_{NOAEL}$=1.7; HQ$_{LOAEL}$ <1 for all other COPEC/receptors	**Negligible**	No further evaluation on the basis of terrestrial exposure.
North-Central Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk; Maximum EPCs < LOEC, except for barium (HQ$_{LOEC}$=1.9) and manganese (HQLOEC=2.4). Refined EPCs slightly exceed LOECs for barium (HQ$_{LOEC}$=1.1) and manganese (HQ$_{LOEC}$=1.0). Manganese comparable to background.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ$_{LOAEL}$<1; maximum cyanide HQ$_{NOAEL}$=1.2 to 1.5 and bis(2-ethylhexyl)phthalate (HQ$_{NOAEL}$=3.5 to 5.2). **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ$_{NOAEL}$<1 .	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ$_{NOAEL}$ <1 for all receptors/COPECs. **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; Refined HQ$_{NOAEL}$<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all stations for meadow vole and short-tailed shrew for refined COPECs.	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Western Undeveloped Area	Negligible risk; maximum exposure < LOEC.	Negligible risk. Maximum EPCs < LOEC, except for barium (HQ$_{LOEC}$=2.1) and manganese (HQ$_{LOEC}$=2.0). Refined EPCs < LOEC, except for slight exceedance for barium (HQ$_{LOEC}$=1.2).	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ$_{LOAEL}$<1; maximum HQ$_{NOAEL}$=1.2 to 2.7. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ$_{NOAEL}$<1.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ$_{NOAEL}$=1.3 for short-tailed shrew TEC$_{2,3,7,8\text{-}TCDD}$; all other COPEC/receptors HQ$_{NOAEL}$<1. **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ$_{NOAEL}$=1.1 for short-tailed shrew TEC$_{2,3,7,8\text{-}TCDD}$; all other COPEC/receptors HQ$_{NOAEL}$<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all locations for meadow vole and short-tailed shrew, except TEC$_{2,3,7,8\text{-}TCDD}$ for short-tailed shrew (HQ$_{NOAEL}$=1.1; HQ$_{LOAEL}$ <1)	**Negligible**	No further evaluation on the basis of terrestrial exposure.

Table 8-1
Summary of BERA Findings - Terrestrial Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	Direct Contact Exposure Summary			Wildlife Exposure Summary			Preliminary Conclusions and Recommendations
	Soil Invertebrates	Terrestrial Plant Community	Overall Direct Contact Risk	Birds	Mammals	Overall Wildlife Risk	
Flathead River Riparian Area	Negligible risk; maximum exposure < LOEC.	Negligible risk; maximum exposure < LOEC.	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1; maximum cyanide HQ_{NOAEL}=1.5. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}<1 for modeled COPEC/receptors **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; Refined HQ_{NOAEL}<1. **Small Ranging Receptors:** Negligible risk; < NOAEL for all locations for meadow vole and short-tailed shrew.	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Incremental Soil Sampling (ISS) Area	Moderate risk. Limited risk to soil invertebrates. Maximum EPCs > LOEC for copper (HQ_{LOEC}=1.7) and zinc HQ_{LOEC}=1.8). Maximum EPCs > NOECs for LMW PAHs (HQ_{NOEC}=74.6) and HMW PAHs (HQ_{NOEC}=68.3); LOECs not identified for LMW and HMW PAHs. Refined EPC > LOEC for copper (HQ_{LOEC}=1.4); refined EPCs > NOECs for LMW PAHs (HQ_{NOEC}=3.0) and HMW PAHs (HQ_{NOEC}=4.3); LOECs not identified for LMW and HMW PAHs.	Negligible risk; Maximum EPC slightly exceeds LOEC for barium (HQ_{LOEC}=1.2), copper (HQ_{LOEC}=1.8), selenium (HQ_{LOEC}=4.4), and zinc (HQ_{LOEC}=2.1). Refined EPCs < LOEC, except slight exceedance of copper (HQ_{LOEC}=1.5).	**Moderate**	Exposure evaluated as part of Central Landfills Area and Main Plant Area evaluations.	**Small Ranging Receptors:** Potential for adverse effects greatest for small mammals in northern portion of Main Plant within the Operational Area footprint; short-tailed shrew exposure > LOAEL at 10 of 43 grids and meadow vole exposure > LOAEL at 1 of 43 grids.	**Moderate**	Impacts from PAHs and metals to local terrestrial plant and invertebrate communities via direct contact and small-ranging mammalian populations via direct and indirect ingestion possible. Ecological exposure pathways limited under current, disturbed conditions; however, further evaluation of exposure may be warranted if future site conditions return these areas to a more naturalized habitat condition that supports ecological receptor populations.

Notes:
COPEC, Constituent of potential ecological concern.
EPC, Exposure point concentrations
HMW PAHs, High molecular weight polycyclic aromatic hydrocarbons
HQ, Hazard quotient; ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
LMW PAHs, Low molecular weight polycyclic aromatic hydrocarbons
LOAEL, Lowest observed adverse effect level dose.
LOEC, Lowest observed effect concentration.
NOAEL, No observed adverse effect level dose.
NOEC, No observed effect concentration.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCL_{mean}) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.

Table 8-2
Summary of BERA Findings - Transitional Exposure Areas - Terrestrial Scenario
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	Direct Contact Exposure Summary		Overall Direct Contact Risk	Wildlife Exposure Summary		Overall Wildlife Risk	Preliminary Conclusions and Recommendations
	Soil Invertebrates	Terrestrial Plant Community		Birds	Mammals		
North Percolation Ponds	High Risk. Maximum EPCs > NOEC for LMW PAHs (HQ_{NOEC}=307 to 311) and HMW PAHs (HQ_{NOEC}=763); maximum EPCs for cyanide, fluoride, and metals < LOEC. Refined EPCs result in HQ_{NOEC} > 100 for LMW and HMW PAHs.	High Risk. HQ_{LOEC} > 1 based on maximum exposure to 7 metals, with HQ_{LOEC} values from 1.1 (zinc and selenium) to 9.2 (thallium). Refined EPCs > LOEC for nickel (HQ_{LOEC}=1.3), thallium (HQ_{LOEC}=3.8), and vanadium (HQ_{LOEC}=1.4). Exposure to LMW and HMW PAHs is uncertain due to lack of NOEC/LOEC benchmarks.	**High**	**Maximum scenario:** High Risk. Potential for adverse effects to birds exposed to cyanide, barium, nickel, selenium, vanadium, LMW PAHs, HMW PAHs, (HQ_{LOAEL}=1.1 to 704) if foraging at maximum exposure exclusively within the North Percolation Pond **Refined scenario:** High Risk. Potential for adverse effects to all avian receptors exposed to nickel, selenium, vanadium, LMW PAHs, and HMW PAHs based on exclusive foraging at refined EPCs (HQ_{LOAEL}=1.8 to 146.5).	**Maximum scenario:** High Risk. Potential for adverse effects to mammals exposed to nickel, LMW PAHs, HMW PAHs, (HQ_{LOAEL}=2.3 to 65) if foraging at maximum exposure exclusively within the North Percolation Pond **Refined scenario:** High Risk. Potential for adverse effects to the Canada lynx, grizzly bear, meadow vole, and short-tailed shrew exposed to nickel and HMW PAHs based on exclusive foraging at refined EPCs (HQ_{LOAEL}=2.3 to 23). HQ_{LOAEL} values below 1 for all receptors except the meadow vole (HMW PAHs) and short-tailed shrew (nickel and HMW PAHs) when area use factor included.	**High**	Greatest potential for adverse effects is associated with exposure to PAHs and metals, particularly in the North-East Pond. Risk due to direct contact and direct and indirect ingestion pathways is high. Further risk assessment may not be beneficial, particularly in the North-East Pond; evaluate future use of North Percolation Pond prior to developing ERA recommendations.
South Percolation Ponds	Negligible risk; Maximum EPCs < LOEC, except for copper (HQ_{LOEC}=1.3) and mercury (HQ_{LOEC}=2.8). Refined EPCs < LOEC.	Negligible risk; Maximum EPCs < LOEC, except for barium (HQ_{LOEC}=3.7) and copper (HQ_{LOEC}=1.4). Refined EPCs < LOEC, except for barium (HQ_{LOEC}=2.5).	**Negligible**	**Maximum scenario:** Minimal Risk. Low potential for adverse effects to birds exposed to copper and BEHP (HQ_{LOAEL}=1.6 to 1.7) if foraging at maximum exposure exclusively within the South Percolation Pond; all other COPEC/receptors HQ_{LOAEL}<1 **Refined scenario:** Minimal Risk. Low potential for adverse effects to American woodcock (HQ_{LOAEL}=1.2) and yellow-billed cuckoo (HQ_{NOAEL}=1.7) foraging at refined EPCs; all other COPEC HQ_{LOAEL}<1.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1 **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; short-tailed shrew had HQNOAEL > 1 for cadmium, copper, and nickel, but all HQ_{LOAEL}<1 based on refined EPCs.	**Minimal**	No further evaluation on the basis of terrestrial exposure.
Cedar Creek Reservoir Overflow Ditch	Negligible risk; maximum exposure < LOEC.	Negligible risk; maximum exposure < LOEC, except for slight exceedances of barium (HQ_{LOEC}=1.1) and manganese (HQ_{LOEC}=1.5).	**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{NOAEL}=1 (zinc for yellow-billed cuckoo). **Refined scenario:** Negligible risk; < LOAEL for all receptors/COPECs based on refined EPCs.	**Maximum scenario:** Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk; HQ_{LOAEL}<1 for all receptor/COPECs.	**Negligible**	No further evaluation on the basis of terrestrial exposure.
Northern Surface Water Feature	Negligible risk; maximum exposure < LOEC.	Negligible risk; maximum exposure < LOEC, except for slight exceedances of barium (HQ_{LOEC}=2.3).	**Negligible**	**Maximum scenario:** Negligible potential for adverse effects to terrestrial birds. All HQ_{LOAEL}<1 based on maximum EPCs. **Refined scenario:** Negligible risk; < LOAEL for all receptors/COPECs based on refined EPCs..	**Maximum scenario:** Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk; HQ_{LOAEL}<1 for all receptor/COPECs.	**Negligible**	No further evaluation on the basis of terrestrial exposure.

Table 8-2
Summary of BERA Findings - Transitional Exposure Areas - Terrestrial Scenario
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Notes:
COPEC, Constituent of potential ecological concern.
EPC, Exposure point concentrations
HMW PAHs, High molecular weight polycyclic aromatic hydrocarbons
HQ, Hazard quotient; ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
LMW PAHs, Low molecular weight polycyclic aromatic hydrocarbons
LOAEL, Lowest observed adverse effect level dose.
LOEC, Lowest observed effect concentration.
NOAEL, No observed adverse effect level dose.
NOEC, No observed effect concentration.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCL_{mean}) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.

Table 8-3
Summary of BERA Findings - Transitional Exposure Areas - Aquatic Scenario
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	Direct Contact Exposure Summary			Overall Direct Contact Risk	Wildlife Exposure Summary		Overall Wildlife Risk	Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles		Birds	Mammals		
North Percolation Ponds	**Surface Water:** High Risk. Maximum fluoride exceed LOEC for invertebrates (HQ_{LOEC}=5.2 to 5.5) and fish/amphibian communities (HQ_{LOEC}=3.6 to 3.7); maximum metals concentrations exceed LOEC for aluminum, barium, cadmium, copper, zinc [HQ_{LOEC}=2.3 to 785 (unfiltered Al)]; maximum concentrations of 7 PAH compounds exceed NOEC (FCV) with HQ_{NOEC}=1.3-14.8. **Sediment:** High Risk. PAH $ESBTU_{34}$>1 at 24 of 30 stations; PAH $ESBTU_{34}$>10 at 13 of 30; Maximum EPCs exceed LOECs for cyanide (HQ_{LOEC}=137) and several metals, with HQ_{LOEC} values ranging from 1.2 (selenium) to 26.0 (nickel). Refined EPCs > LOEC for cyanide (HQ_{LOEC}=41.2) and lead (HQ_{LOEC}=7.5).			**High**	**Maximum scenario:** High Risk. Potential for adverse effects to birds exposed to cyanide, barium, nickel, selenium, vanadium, LMW PAHs, HMW PAHs, (HQ_{LOAEL}=1.1 to 704) if foraging at maximum exposure exclusively within the North Percolation Pond **Refined scenario:** High Risk. Potential for adverse effects to American dipper exposed to selenium, vanadium, LMW PAHs, and HMW PAHs and belted kingfisher exposed to HMW PAHs based on exclusive foraging at refined EPCs (HQ_{LOAEL}=1.4 to 284).	**Maximum scenario:** Negligible risk to mink foraging exclusively within the exposure area at maximum EPCs (HQ_{NOAEL}<1) **Refined scenario:** Negligible risk to mink foraging exclusively within the exposure area at refined EPCs (HQ_{NOAEL}<1)	**High**	Greatest potential for adverse effects via direct contact exposure to fluoride, metals, and PAHs in surface water and sediment, particularly in the North-East Pond. High risk associated with birds foraging in exposure area. Further risk assessment may not be beneficial, particularly in the North-East Pond; evaluate future use of North Percolation Pond prior to developing ERA recommendations.
South Percolation Ponds	**Surface Water:** Moderate Risk. Maximum EPCs > LOEC for total cyanide (HQ_{LOEC}=3.1 to 6.3), aluminum, barium (HQ_{LOEC}=8.0 to 20.2), copper, and iron (HQ_{LOEC}=2.3); sample-specific LOEC exceeded in for aluminum in 2/17 filtered samples (HQ_{LOEC}=1.0-3.1), aluminum in 2/26 unfiltered samples (HQ_{LOEC}=1.2 to 11.7), filtered copper in 1/17 samples (HQ_{LOEC}=1.1-1.2), unfiltered copper in 1/26 samples (HQ_{LOEC}=1.1). Refined EPCs > LOEC for cyanide (HQ_{LOEC}=2.4) and barium (HQ_{LOEC}=8.0 to 20.2). **Sediment:** Moderate Risk. Maximum EPCs > LOEC for cyanide (HQ_{LOEC}=16.4) and several metals (HQ_{LOEC}=1.1 to 5.0); Refined EPCs > LOEC for cyanide (HQ_{LOEC}=4.4), barium (HQ_{LOEC}=2.1), and copper (HQ_{LOEC}=1.4). AVS-SEM/f_{oc} not indicative of adverse effects to metals; **Pore water:** Moderate Risk. Aluminum and copper < LOEC in pore water samples; maximum EPC for barium exceeds LOEC (HQ_{LOEC}=10.8).			**Moderate**	**Maximum scenario:** Minimal Risk**.** Low potential for adverse effects to birds exposed to barium and copper (HQ_{LOAEL}=2.3 to 3.5) if foraging at maximum exposure exclusively within the South Percolation Pond; all other COPEC/receptors HQ_{LOAEL}<1 **Refined scenario:** Minimal Risk. Low potential for adverse effects to American dipper exposed to barium (HQ_{LOAEL}=2.3) foraging at refined EPCs; all other COPEC HQ_{LOAEL}<1 for American dipper and belted kingfisher.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{NOAEL}<1 **Refined scenario:** Negligible risk to mammals foraging exclusively within the exposure area; H_{QNOAEL}<1 based on refined EPCs.	**Minimal**	Greatest potential for adverse effects via direct contact exposure to cyanide, metals, and PAHs in surface water. Evaluate potential for minimizing stormwater discharge with elevated concentrations of cyanide, aluminum, and other COPECs to the South Percolation Ponds.
Cedar Creek Reservoir Overflow Ditch	**Surface Water:** Negligible risk. Maximum EPCs > LOEC for aluminum, barium (HQ_{LOEC}= 5.4 to 5.6), and manganese (HQ_{LOEC}= 1.6). Aluminum LOEC (NRWQC CMC) exceeded in 1 of 27 samples (HQ_{LOEC}=6.5); filtered aluminum < NOEC. Refined exposure to barium results in HQ_{LOEC}= 2.6 to 2.7. Barium concentrations consistent upstream to downstream across site, with the exception of Oct 2018 result at CFSWP-039, indicating potential upgradient conditions. **Sediment:** Minimal Risk. Limited potential for adverse effects to benthic invertebrates associated with exposure to cyanide, manganese, and PAHs. Maximum EPCs > LOEC for cyanide (HQ_{LOEC} = 1.5), manganese (HQ_{LOEC} = 1.5), and PAHs (ESBTU = 7.7 to 21.2) . PAH $ESBTU_{34}$ < 1 for all stations except CFSB-284 (tPAHs=7.4; low TOC=0.006%). Refined EPCs < 1 for all COPECs, except manganese (HQ_{LOEC} = 1.2).			**Minimal**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}=1.1 (barium for American dipper). **Refined scenario:** Negligible risk; < LOAEL for all receptors/COPECs based on refined EPCs.	**Maximum scenario:** Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk; HQ_{LOAEL}<1 for all receptor/COPECs.	**Negligible**	No further evaluation on the basis of aquatic exposure.

Table 8-3
Summary of BERA Findings - Transitional Exposure Areas - Aquatic Scenario
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	Direct Contact Exposure Summary			Overall Direct Contact Risk	Wildlife Exposure Summary		Overall Wildlife Risk	Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles		Birds	Mammals		
Northern Surface Water Feature	**Surface Water:** Minimal Risk. Maximum EPCs > LOEC for aluminum and barium (HQ_{LOEC}=5.9 to 6.3); Aluminum LOEC (NRWQC CMC) exceeded in 2 of 16 samples (HQ_{LOEC}=1.2 to 1.9); filtered aluminum < NOEC. Refined EPC > LOEC for barium (HQ_{LOEC} = 3.8). **Sediment:** Minimal Risk. Maximum EPCsv > LOEC for barium (HQ_{LOEC} = 3.0) and manganese (HQ_{LOEC} = 1.5); maximum EPCs < LOEC for other COPECs. Refined EPC for barium > LOEC (HQ_{LOEC} = 2.0). PAH $ESBTU_{34}$ < 1 for all stations. **Pore water:** Minimal Risk. Maximum barium EPC > LOEC (HQ_{LOEC}=8.0); maximum EPCs > LOEC for other COPECs.			**Minimal**	**Maximum scenario:** Limited potential for adverse effects to American dipper foraging exclusively at maximum EPCs for barium (HQ_{LOAEL}=3.3) and selenium (HQ_{LOAEL}=3.4). HQ_{LOAEL}<1 for other receptors/COPECs based on maximum EPCs. **Refined scenario:** Limited potential for adverse effects to American dipper foraging exclusively at refined EPCs for barium (HQ_{LOAEL}=2.1)and selenium (HQ_{LOAEL}=1.2); HQ_{LOAEL}<1 for other receptors/COPECs based on refined EPCs.	**Maximum scenario:** Negligible risk. Mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk; HQ_{LOAEL}<1 for all receptor/COPECs.	**Minimal**	No further evaluation on the basis of aquatic exposure.

Notes:
COPEC, Constituent of potential ecological concern.
EPC, Exposure point concentrations
HMW PAHs, High molecular weight polycyclic aromatic hydrocarbons
HQ, Hazard quotient; ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
LMW PAHs, Low molecular weight polycyclic aromatic hydrocarbons
LOAEL, Lowest observed adverse effect level dose.
LOEC, Lowest observed effect concentration.
NOAEL, No observed adverse effect level dose.
NOEC, No observed effect concentration.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCL_{mean}) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.

Table 8-4
Summary of BERA Findings - Aquatic Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

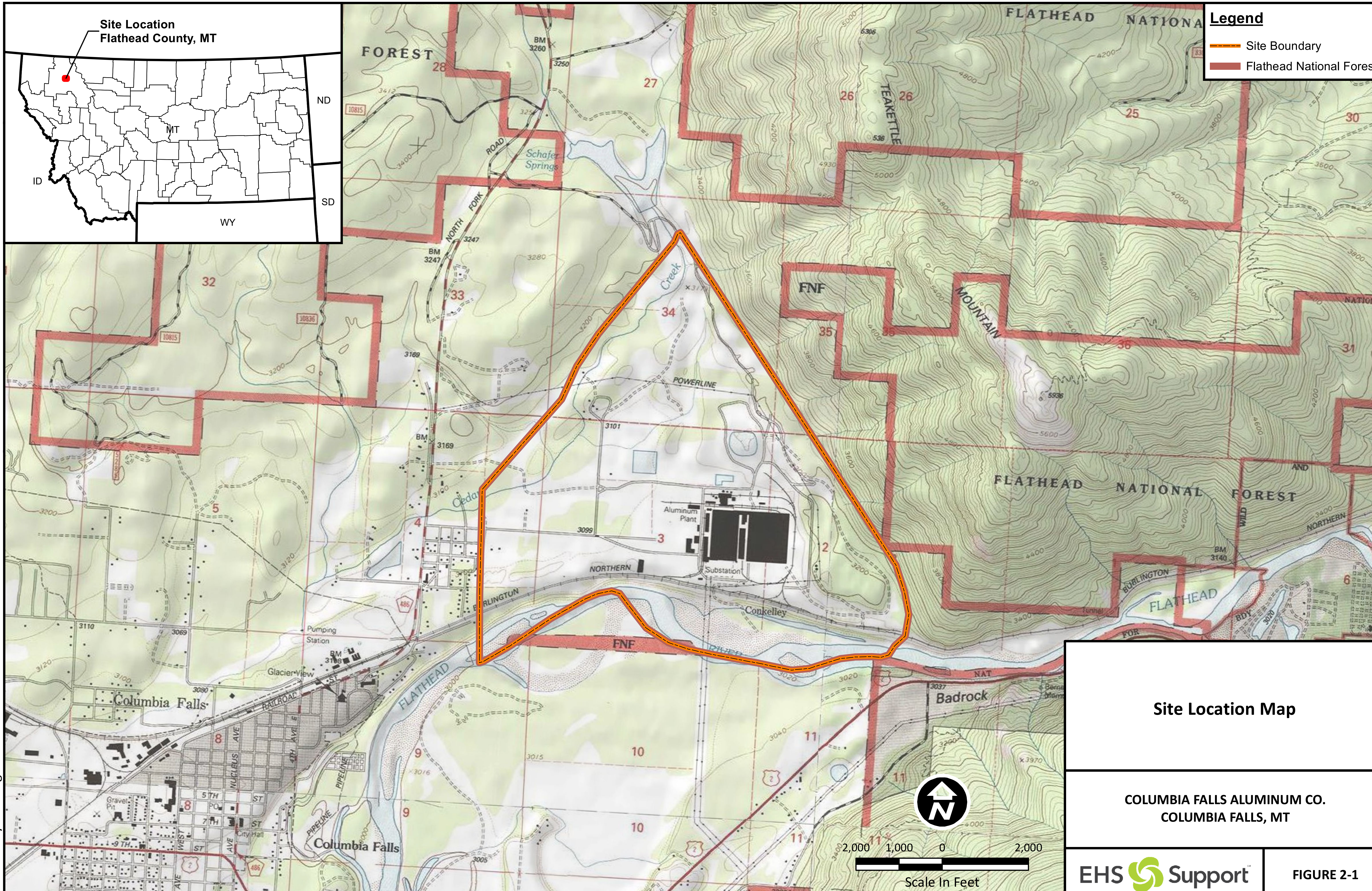
Exposure Area	Direct Contact Exposure Summary			Overall Direct Contact Risk	Wildlife Exposure Summary		Overall Wildlife Risk	Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles		Birds	Mammals		
Flathead River	**Surface Water:** Moderate risk. Total cyanide exceeds LOEC (acute) in maximum and refined exposure scenarios; free cyanide concentrations result in HQ_{OEC} 1.1 to 1.2 based on refined exposure scenario. Refined exposure estimate for barium results in HQ_{LOEC}=2.7-3.0. Aluminum LOEC (NRWQC CMC) exceeded in 8 of 76 samples (HQ_{LOEC}=1.6 to 17.7); filtered aluminum < NOEC. **Sediment:** Minimal Risk. Potential exposure to cyanide associated with aqueous exposure to pore water; potential exposure to tPAHs primarily associated with sampling stations in the Backwater Seep Sampling Area with $ESBTU_{34}$ values < 1, except for CFSDP-036 on the Flathead River that had tPAH = 1.35 mg/kg with low TOC (0.01 %) **Pore water:** Moderate Risk. Maximum cyanide (free) exposure in Backwater Seep Sampling Area sampling stations exceed NOEC and LOEC (acute), with HQ_{NOEC} and HQ_{LOEC} of 12.0 and 2.8, respectively. Maximum exposure to barium results in HQLOEC=6.7. Negligible exposure to fluoride (maximum HQ_{NOEC}=1.7; HQ_{LOEC}<1).			**Moderate**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area at maximum EPCs; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; HQ_{LOAEL}<1 based on refined EPCs.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1 for all receptors/COPECs. Maximum EPC for HMW PAHs > NOAEL (HQ_{NOAEL}= 6.7). **Refined scenario:** Negligible risk based on refined EPCs; HQ_{NOAEL} for HMW PAHs = 1.5 for mink, but HQ_{LOAEL}<1.	**Negligible**	Greatest potential for adverse effects via direct contact exposure is associated with exposure to cyanide, aluminum, and barium in surface water and pore water at stations in the Backwater Seep Sampling Area. Further evaluation of chronic, direct contact exposure to cyanide in surface water and pore water may be warranted.
Flathead River Excluding Backwater Seep Area	**Surface Water:** Minimal Risk. No exceedances of NOEC for total cyanide or free cyanide. Unfiltered aluminum exceeds LOEC (NRWQC CMC) in 3 of 40 samples (HQ_{LOEC}=3.5 to 17.7); filtered aluminum < NOEC. Refined exposure estimate for barium results in HQ_{LOEC}=2.1-2.4. **Sediment:** Minimal Risk. Potential exposure to tPAHs with $ESBTU_{34}$ values > 1 limited to CFSDP-036 (tPAH = 1.35 mg/kg; TOC 0.01 %); AVS-SEM/f_{oc} not indicative of adverse effects to metals; cyanide (free and total) < NOEC. **Pore water:** Minimal Risk. Maximum exposure to barium results in HQ_{LOEC}=6.7; barium concentrations consistent upgradient to downgradient, indicating concentrations are representative of upgradient/background conditions. Cyanide (free and total) < NOEC.			**Minimal**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area at maximum EPCs; maximum HQ_{LOAEL}<1. **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; HQ_{LOAEL}<1 based on refined EPCs.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum HQ_{LOAEL}<1 for all receptors/COPECs. Maximum EPC for HMW PAHs > NOAEL (HQ_{NOAEL}= 6.7). **Refined scenario:** Negligible risk based on refined EPCs (HQ_{NOAEL}<1).	**Negligible**	Potential for adverse effects is substantially lower in Flathead River sampling stations outside of the Backwater Seep Sampling Area. No further evaluation on the basis of ecological risk for the Flathead River outside of the Backwater Seep Sampling Area.
Flathead River Riparian Channel	**Surface Water:** Moderate Risk. Total cyanide exceeds LOEC (NRWQC CMC) in maximum and refined exposure scenarios; free cyanide concentrations result in HQ_{LOEC} 2.0 to 2.8 based on refined exposure scenario. Refined exposure estimate for barium results in HQ_{LOEC}=6.9-16.1. Aluminum NOEC (NRWQC CCC) exceeded in 6 of 15 samples (HQ_{NOEC}=1.2-41.6); Aluminum LOEC (NRWQC CMC) exceeded in 3 of 15 samples (HQ_{LOEC}=1.8-10.7); filtered aluminum < LOEC. Unfiltered copper > NOEC and LOEC in 2 of 15 samples (HQ_{LOEC}=1.0-2.0); filtered copper < NOEC. **Sediment:** Minimal Risk. Potential exposure to cyanide associated with aqueous exposure to pore water; potential exposure to tPAHs primarily associated with CFSDP-029 nearest the Backwater Seep Sampling Area ($ESBTU_{34}$ = 4.0); $ESBTU_{34}$ values < 1 at other stations. **Pore water:** Moderate Risk**.**Cyanide (free) exceed LOEC (NRWQC CMC) in 3 of 6 samples (max HQ_{LOEC}=7.4 at CFSDP-029); Free cyanide exceeds NOEC in 4 of 6; Maximum barium EPC results in HQ_{LOEC}=10.1. Other COPECs < LOEC; PAHs < NOEC. Aluminum not identified as as refined COPEC.			**Moderate**	Not evaluated as a separate wildlife exposure area.	Not evaluated as a separate wildlife exposure area.	**Not Applicable**	Greatest potential for adverse effects via direct contact exposure is associated with exposure to cyanide, aluminum, and barium in surface water and pore water. Further evaluation of chronic, direct contact exposure to cyanide in surface water and pore water may be warranted.

Table 8-4
Summary of BERA Findings - Aquatic Exposure Areas
Baseline Ecological Risk Assessment
Columbia Falls Aluminum Company
Columbia Falls, Montana

Exposure Area	Direct Contact Exposure Summary			Overall Direct Contact Risk	Wildlife Exposure Summary		Overall Wildlife Risk	Preliminary Conclusions and Recommendations
	Benthic/Pelagic Invertebrate Communities	Aquatic Plant Community	Fish/Herptiles		Birds	Mammals		
Cedar Creek	**Surface Water:** Negligible risk; Refined exposure estimate results in barium HQ_{LOEC}=2.7-2.8; however, barium concentrations consistent with background. Maximum cyanide EPC < LOEC. No other refined COPECs. **Sediment:** Negligible risk; Maximum exposure to cyanide, barium, manganese, and ESBTUs < LOEC; HQ_{NOEC} values range from 1.2 (manganese) to 2.4 (cyanide). **Pore water:**-Negligible risk; Maximum exposure to resulting in HQ_{LOEC} values of 6.9 and 1.2 for barium and manganese, respectively; however, barium concentrations consistent with upgradient/background conditions.			**Negligible**	**Maximum scenario:** Negligible risk to birds foraging exclusively within the exposure area; maximum HQ_{LOAEL}=1.3 (selenium) **Refined scenario:** Negligible risk to birds foraging exclusively within the exposure area; HQ_{LOAEL}<1 based on refined EPCs.	**Maximum scenario:** Negligible risk to mammals foraging exclusively within the exposure area; maximum exposure to cadmium and selenium > NOAEL (HQ_{NOAEL}=2.0-2.4); maximum HQ_{LOAEL}<1. **Refined scenario**: Negligible risk based on refined EPCs (HQ_{NOAEL}<1).	**Negligible**	No further evaluation on the basis of ecological risk.

Notes:
COPEC, Constituent of potential ecological concern.
EPC, Exposure point concentrations
HMW PAHs, High molecular weight polycyclic aromatic hydrocarbons
HQ, Hazard quotient; ratio of direct contact EPC to NOEC/LOEC or estimated daily dose to NOAEL/LOAEL.
LMW PAHs, Low molecular weight polycyclic aromatic hydrocarbons
LOAEL, Lowest observed adverse effect level dose.
LOEC, Lowest observed effect concentration.
NOAEL, No observed adverse effect level dose.
NOEC, No observed effect concentration.
Maximum scenario, Represents worst case exposure scenario by assuming maximum concentrations as EPCs in direct contact evaluation or inputs to EDD doses for wildlife ingestion pathways.
Refined scenario, Represents conservative estimate of average exposure scenario by assuming upper confidence limit of the mean (UCL_{mean}) concentrations as EPCs in direct contact evaluation or inputs to EDD doses for ingestion pathways.

Figures



Site Location Map

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 2-1

Reviewed By: G. Long

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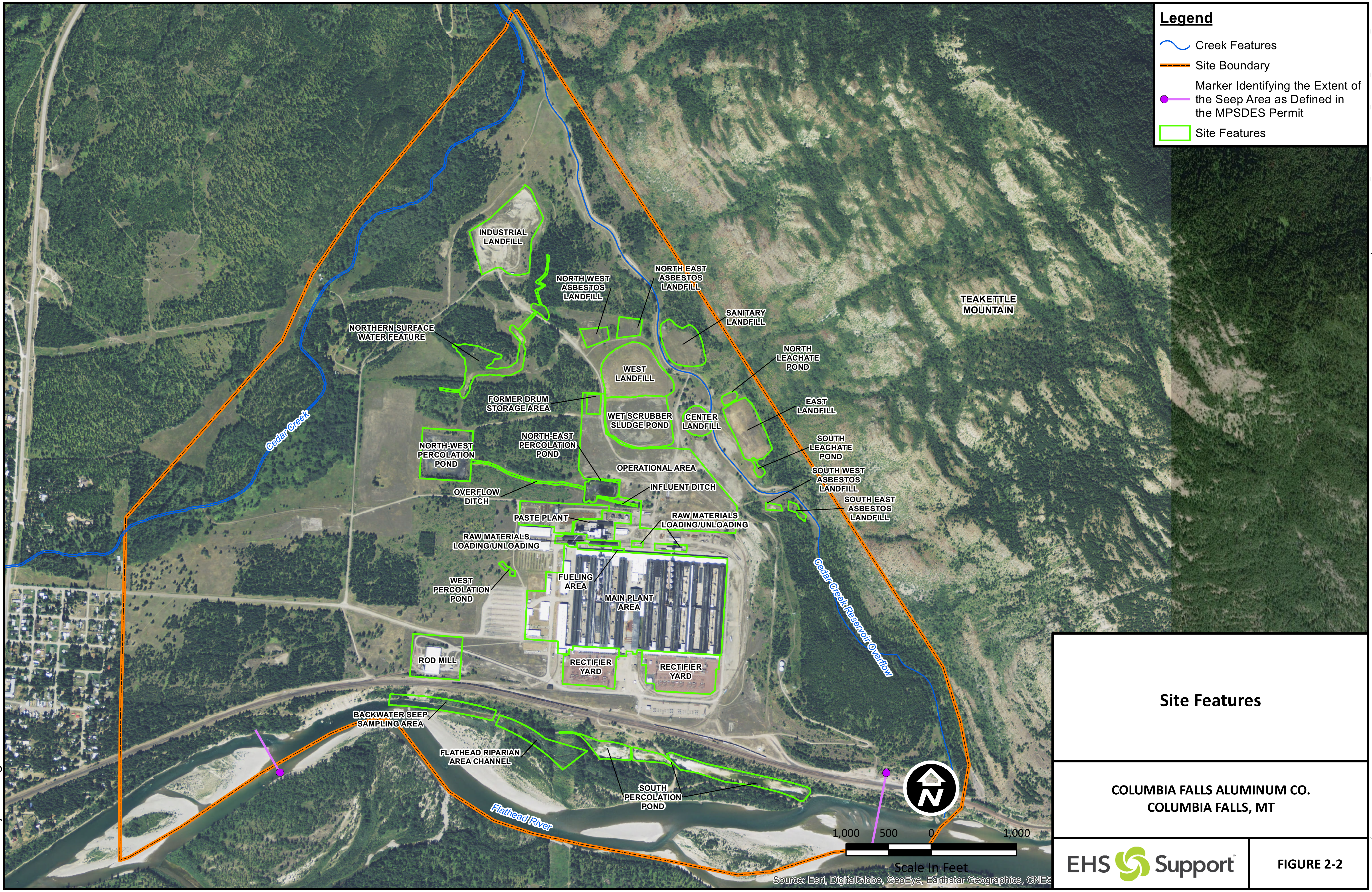

Site Features

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 2-2

Reviewed By: G. Long

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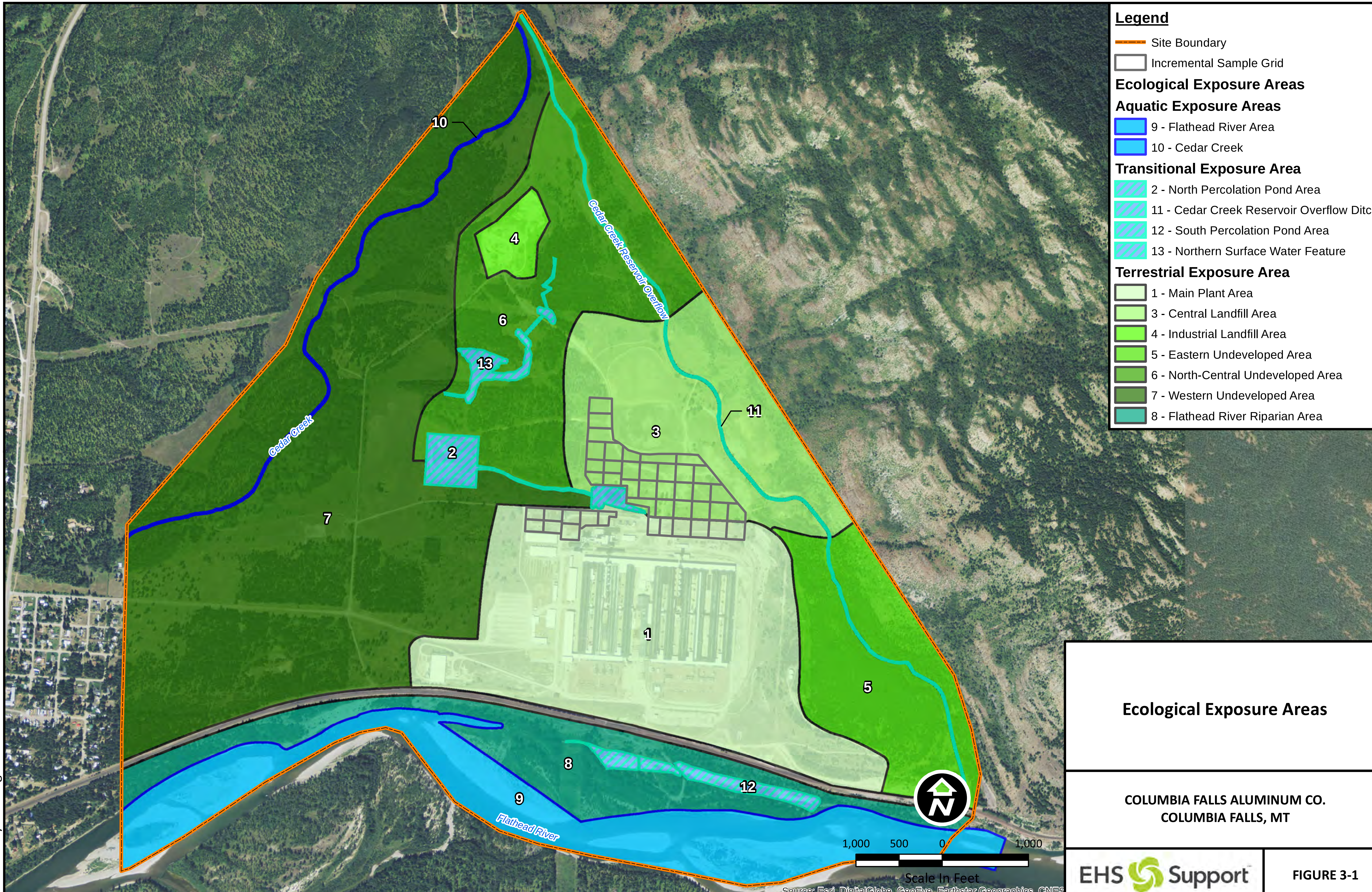

Ecological Exposure Areas

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 3-1

Reviewed By: G. Long

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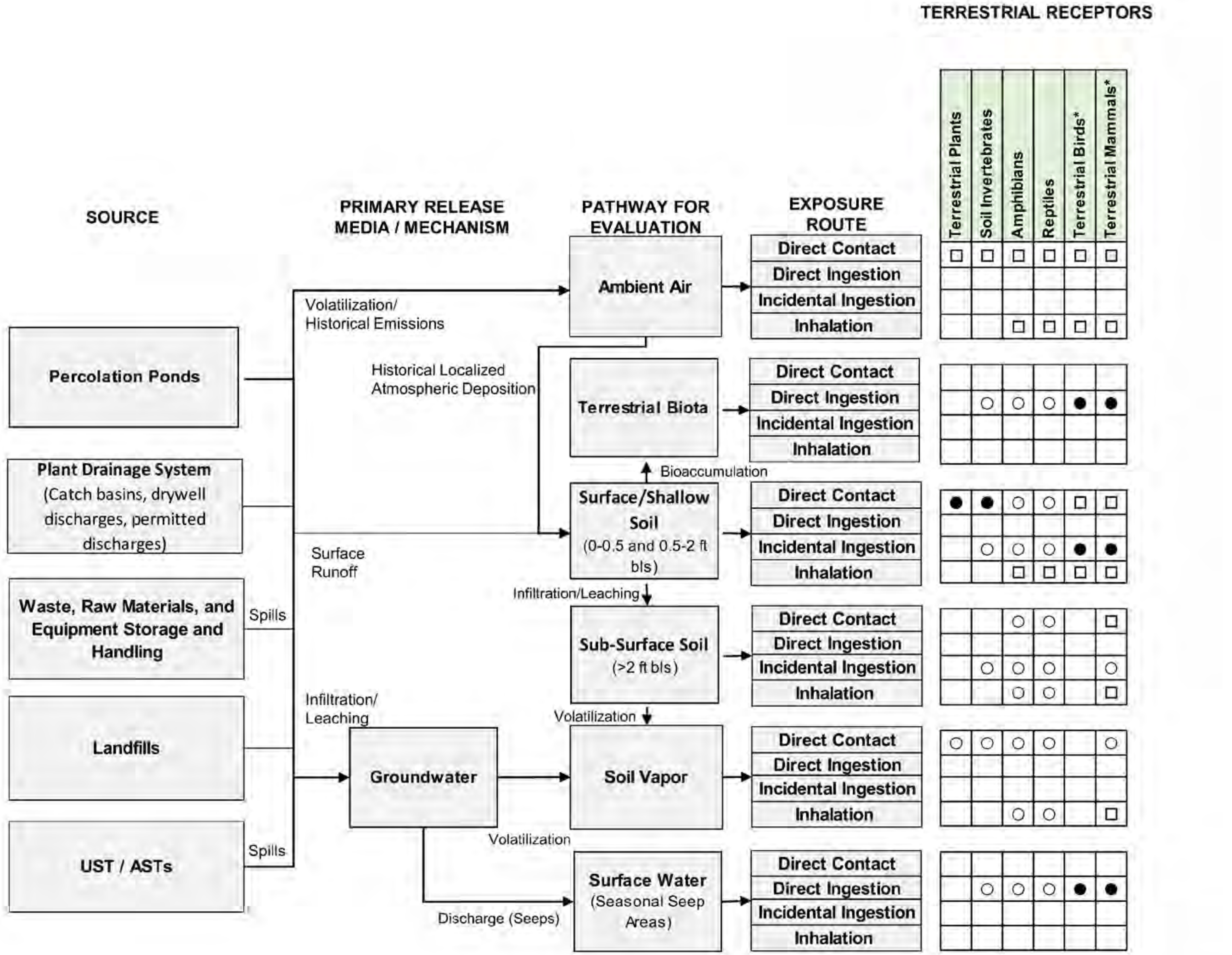

Notes:
Solid circles (●) represent exposure pathways that are considered potentially complete.
Open circles (○) represent potential exposure pathways that are not quantifiable.
Open squares (□) represent potential exposure pathways that are likely insignificant.
*Includes semi-aquatic birds and mammals, where applicable.

ECSM: Terrestrial Exposure Areas

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 3-2

Reviewed By: G. Long

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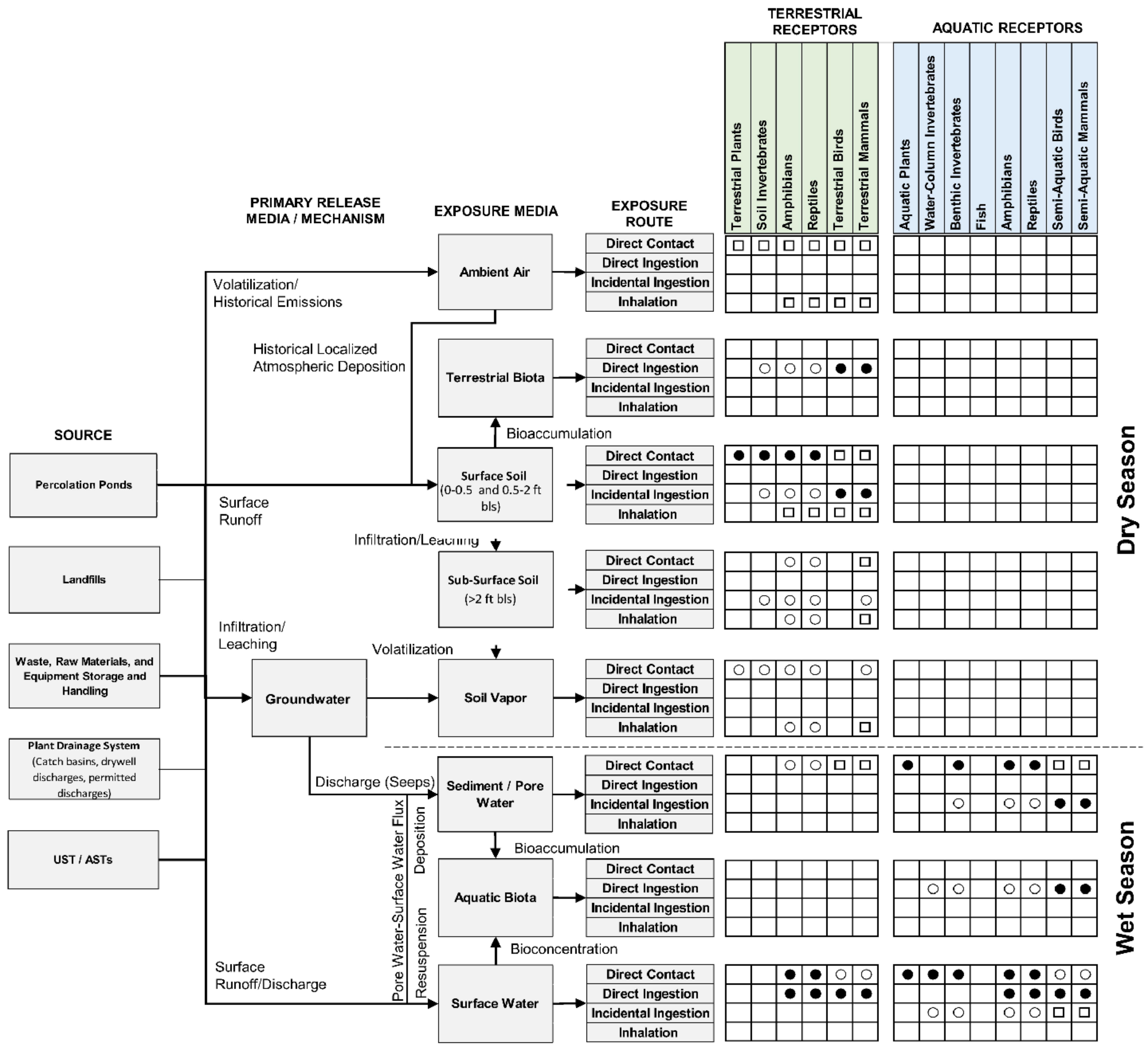

Notes:
Solid circles (●) represent exposure pathways that are considered potentially complete.
Open circles (❍) represent potential exposure pathways that are not quantifiable.
Open squares (☐) represent potential exposure pathways that are likely insignificant.
Permanent aquatic communities (e.g., fish communities) are not likely to be established in transitional exposure areas.

ECSM: Transitional Exposure Areas

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 3-3

Reviewed By: G. Long

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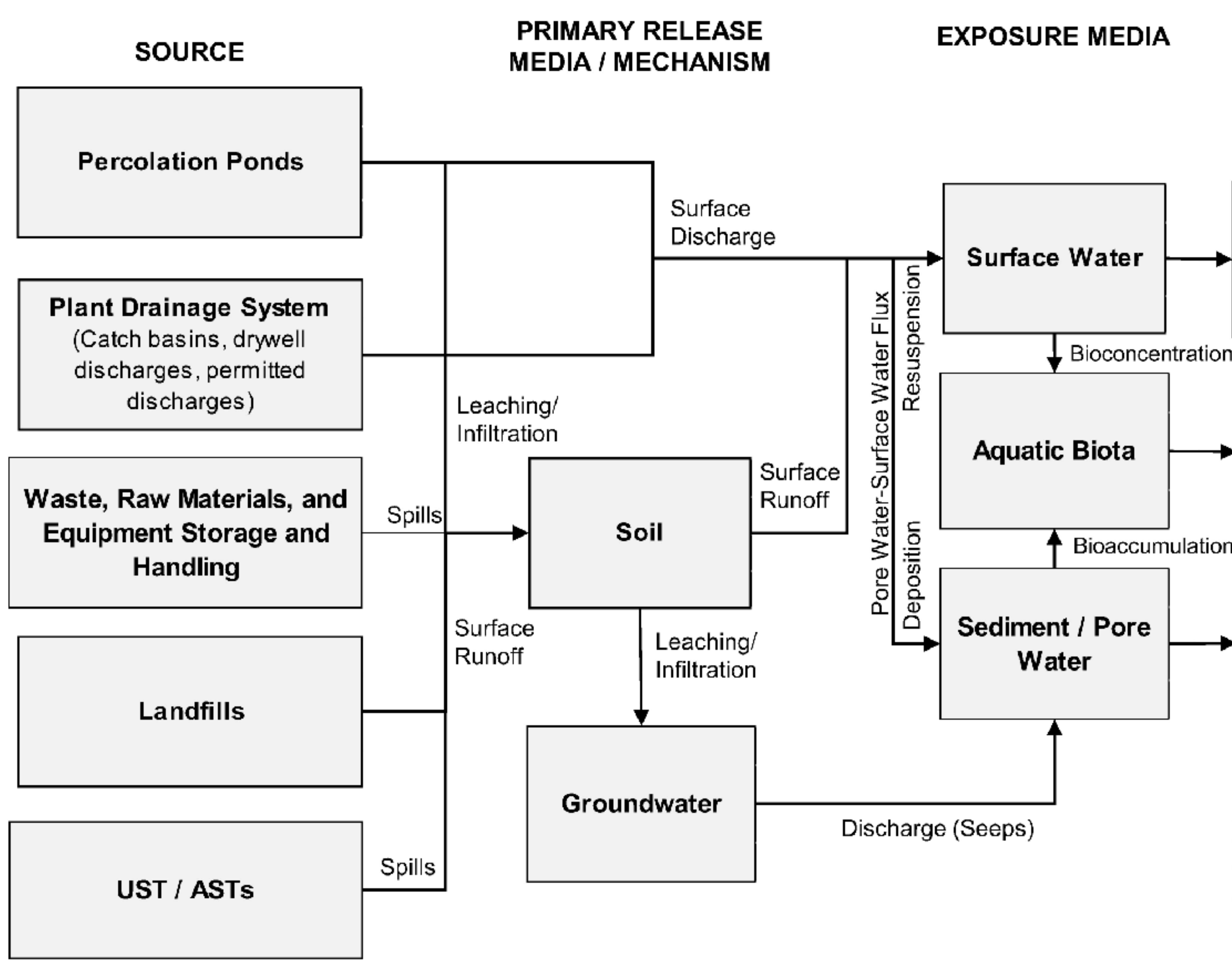

Exposure Media	Exposure Route	Terrestrial Receptors: Terrestrial Plants	Soil Invertebrates	Amphibians	Reptiles	Terrestrial Birds	Terrestrial Mammals	Aquatic Receptors: Aquatic Plants	Water-Column Invertebrates	Benthic Invertebrates	Fish	Amphibians	Reptiles	Semi-Aquatic Birds	Semi-Aquatic Mammals
Surface Water	Direct Contact			●	●	○	○	●	●	●	●	●	●	○	○
	Direct Ingestion			●	●	●	●					●	●	●	●
	Incidental Ingestion								○	○	○	○	○	□	□
	Inhalation														
Aquatic Biota	Direct Contact														
	Direct Ingestion								○	○	○	○	○	●	●
	Incidental Ingestion														
	Inhalation														
Sediment / Pore Water	Direct Contact			○	○	□	□	●		●	●	●	●	□	□
	Direct Ingestion														
	Incidental Ingestion									○	○	○	○	●	●
	Inhalation														

Notes:
Solid circles (●) represent exposure pathways that are considered potentially complete.
Open circles (❍) represent potential exposure pathways that are not quantifiable.
Open squares (□) represent potential exposure pathways that are likely insignificant.

ECSM: Aquatic Exposure Areas

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 3-4

Reviewed By: G. Long

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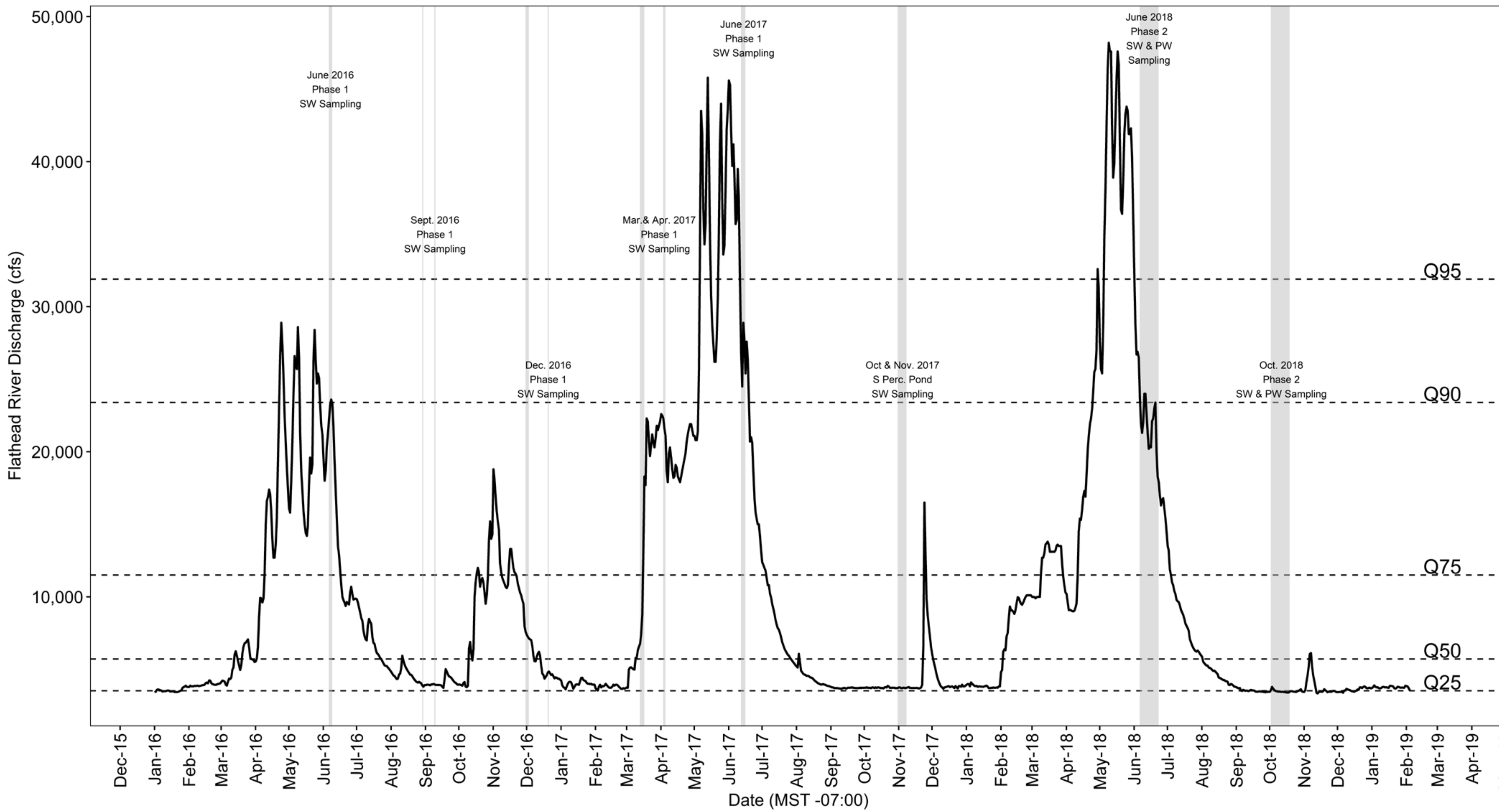


Legend

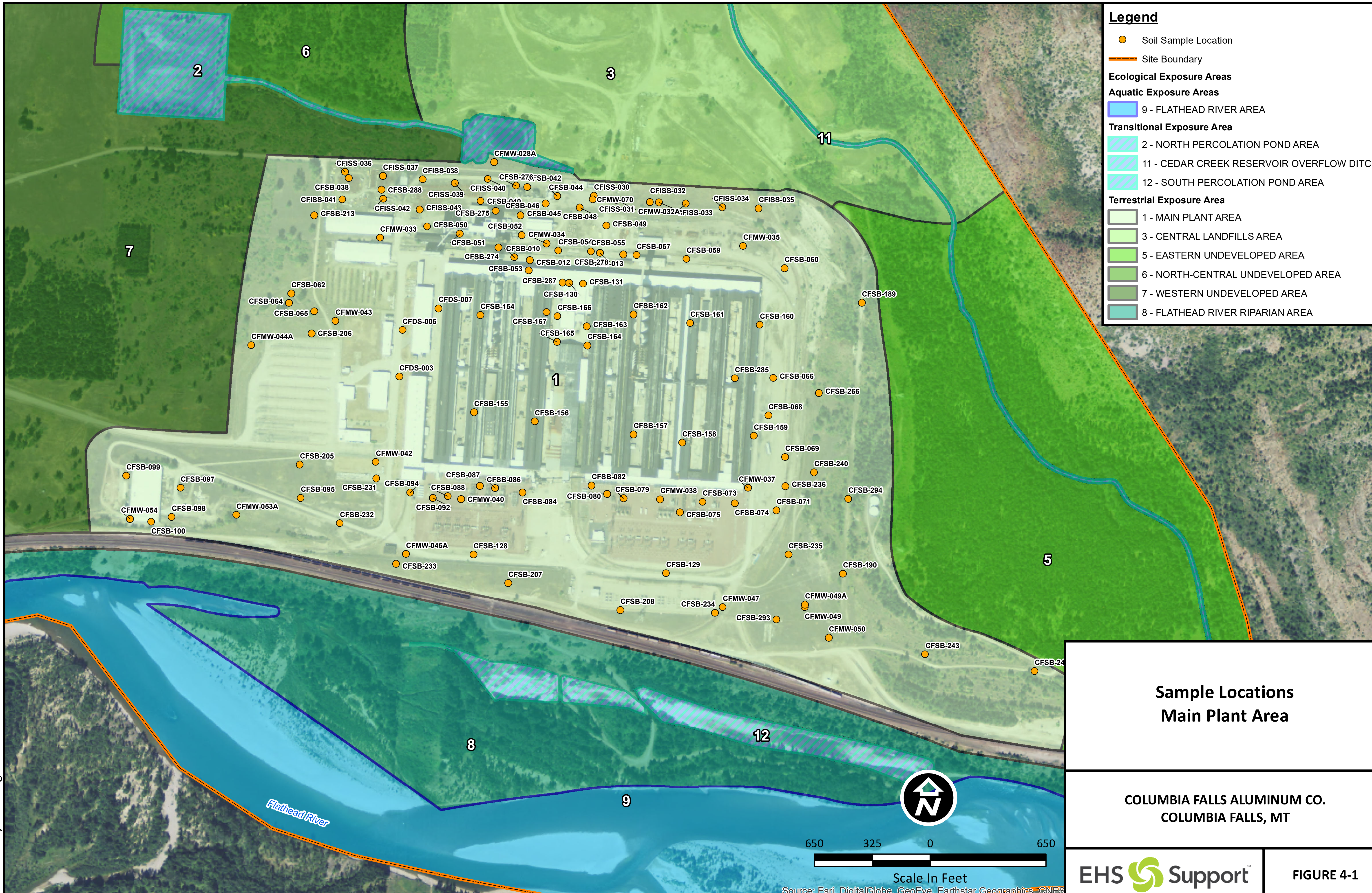
Surface Water or Pore Water Sampling Period
Flathead River Discharge
Discharge (Q) Percentile

FIGURE 3-5

EHS Support

FLATHEAD RIVER DISCHARGE AND LONG-TERM FLOW STATISTICS

Prepared by:	S. Parker	Checked by:	S. Parker
Project:	CFAC - BERA	Date:	February 6, 2019



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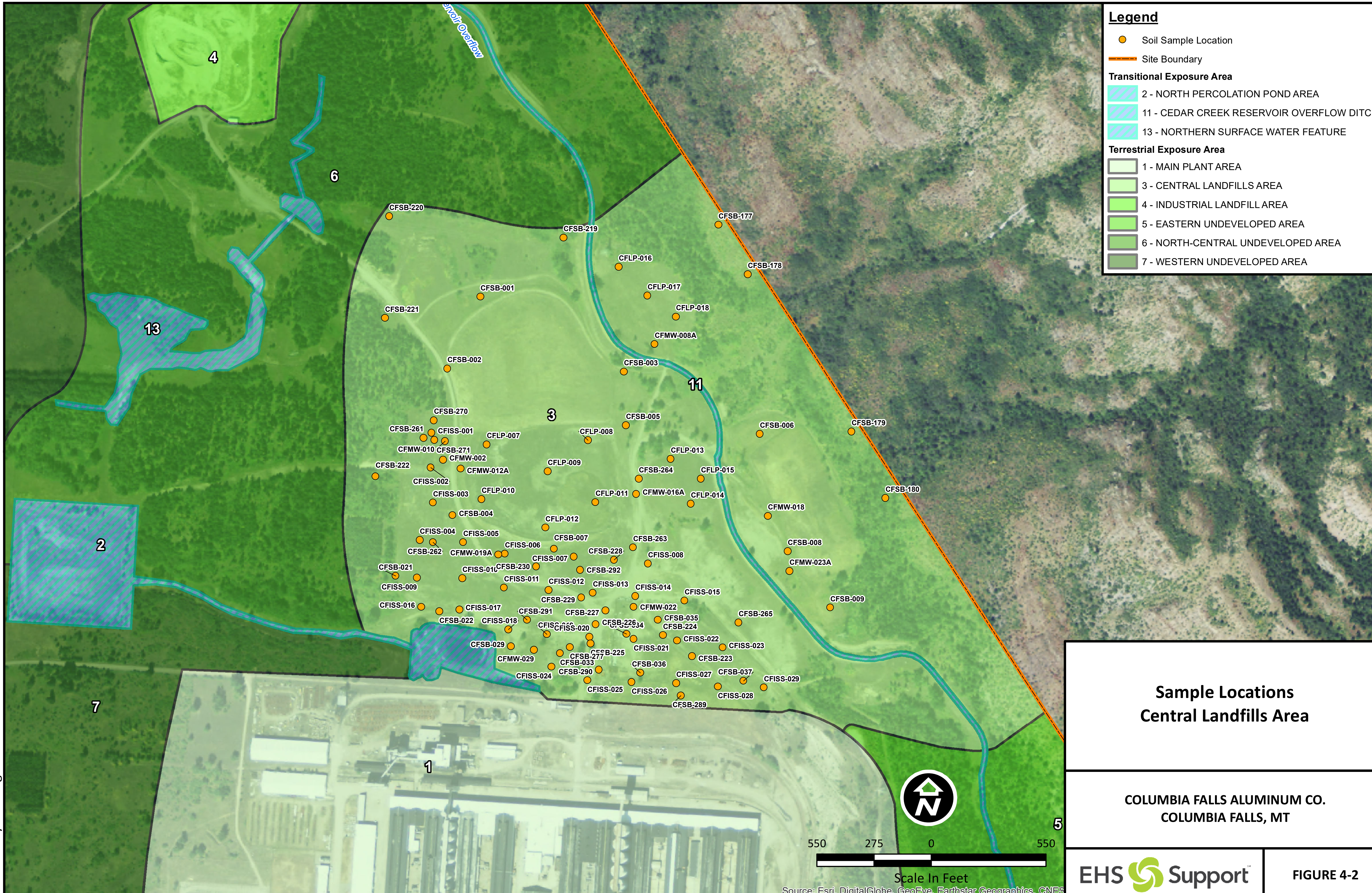

Sample Locations
Central Landfills Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-2

Reviewed By: G. Long

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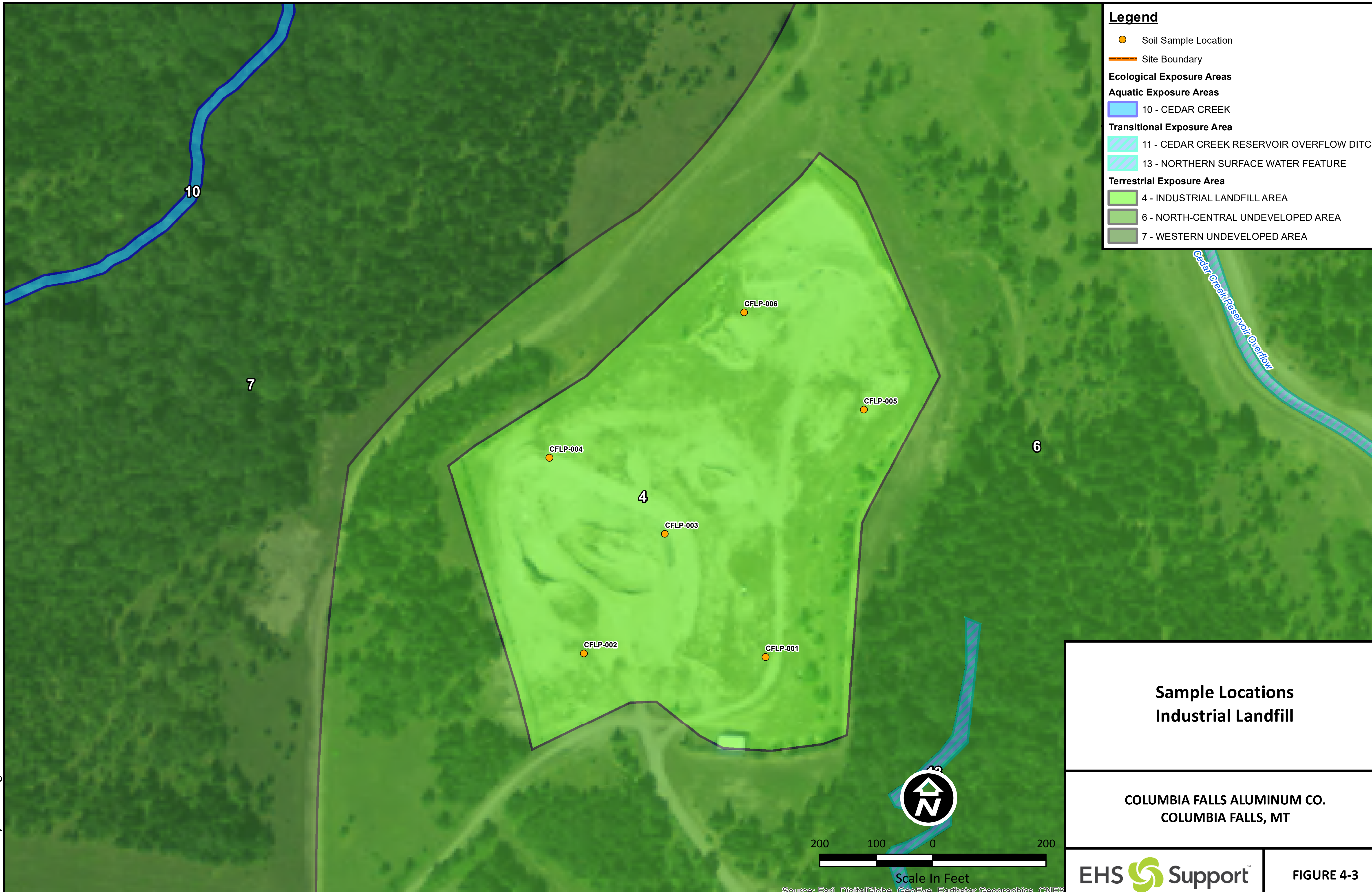

Reviewed By: G. Long

Sample Locations
Industrial Landfill

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-3

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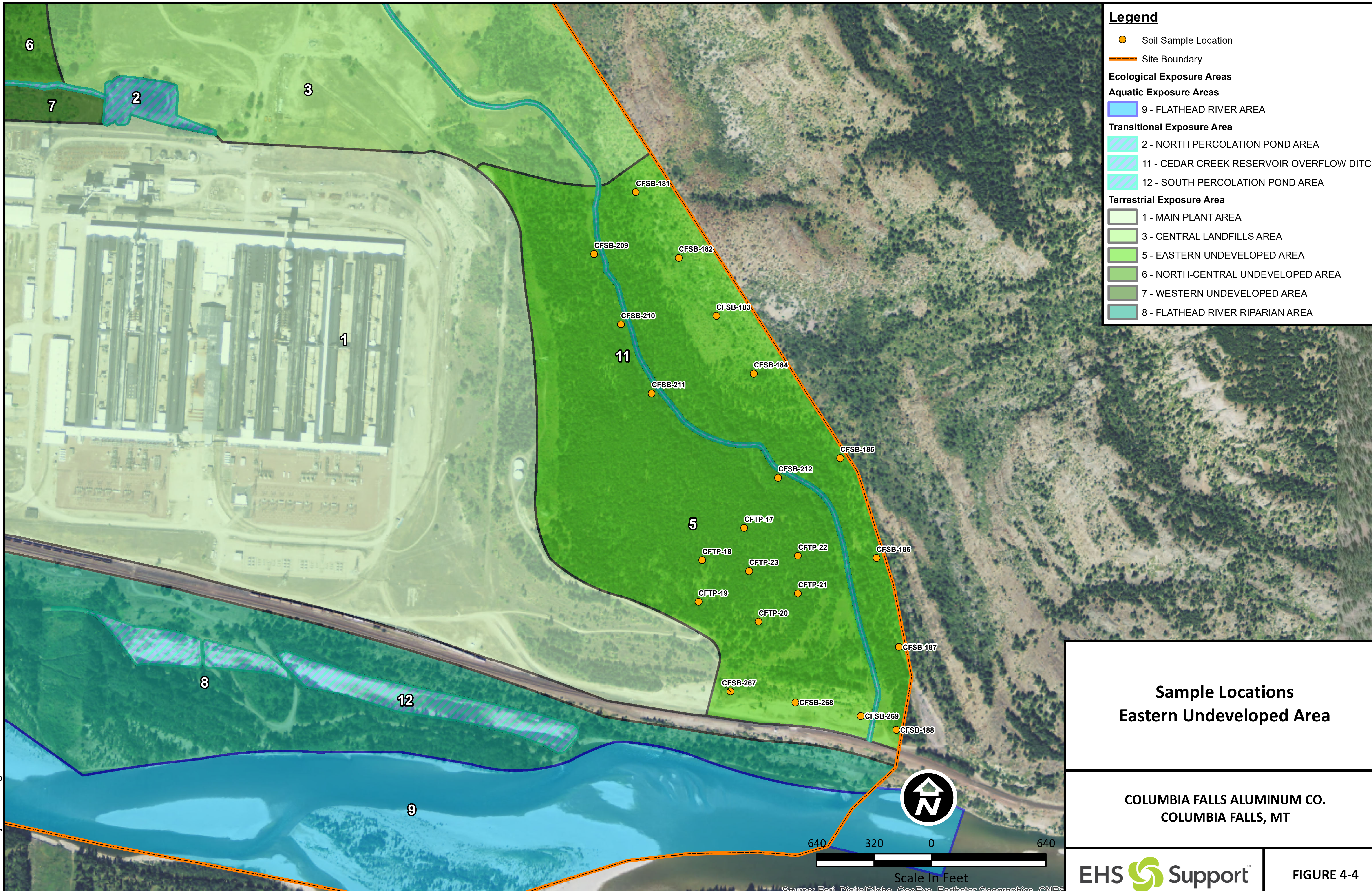

Sample Locations
Eastern Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-4

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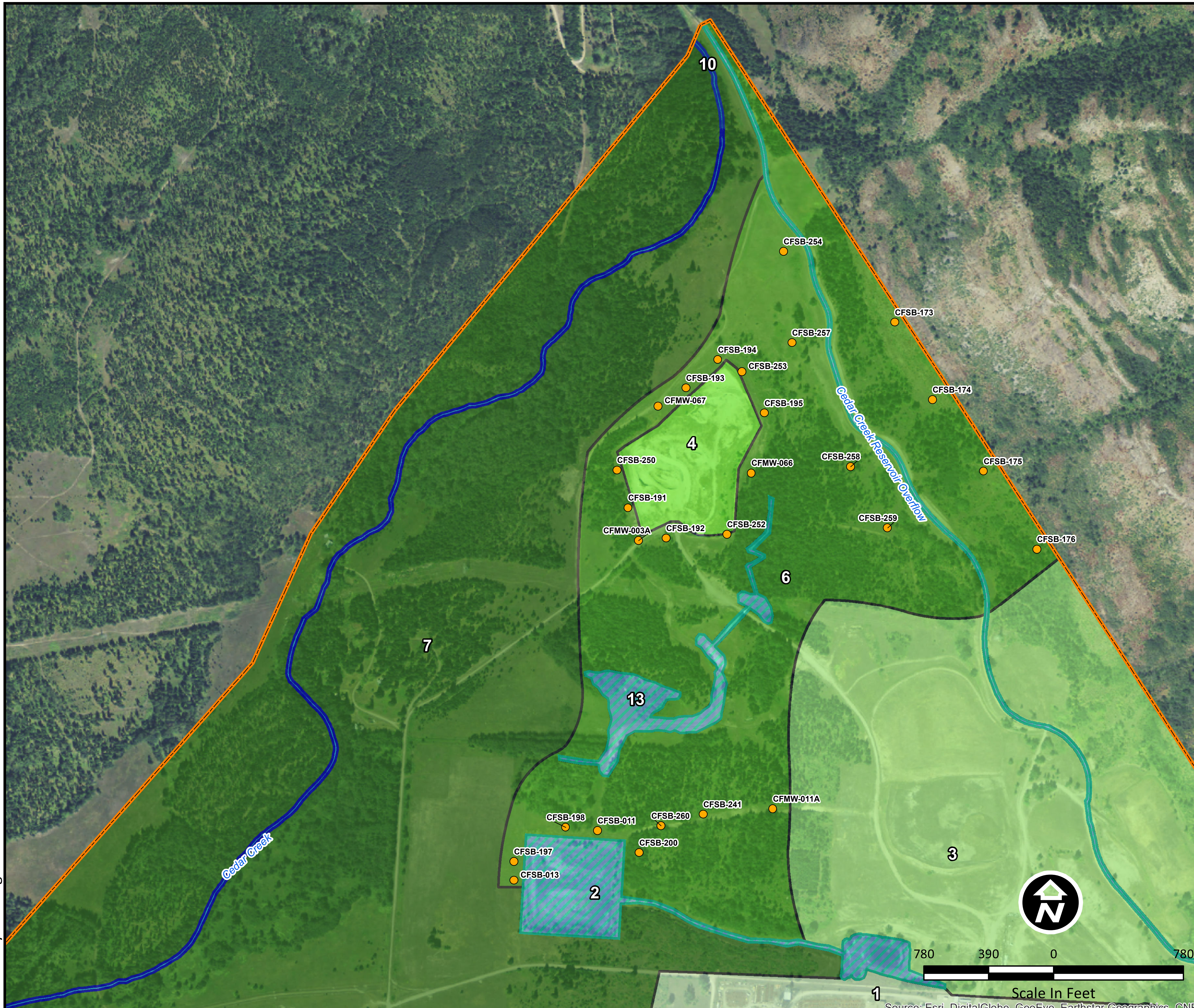

Sample Locations
North-Central Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-5

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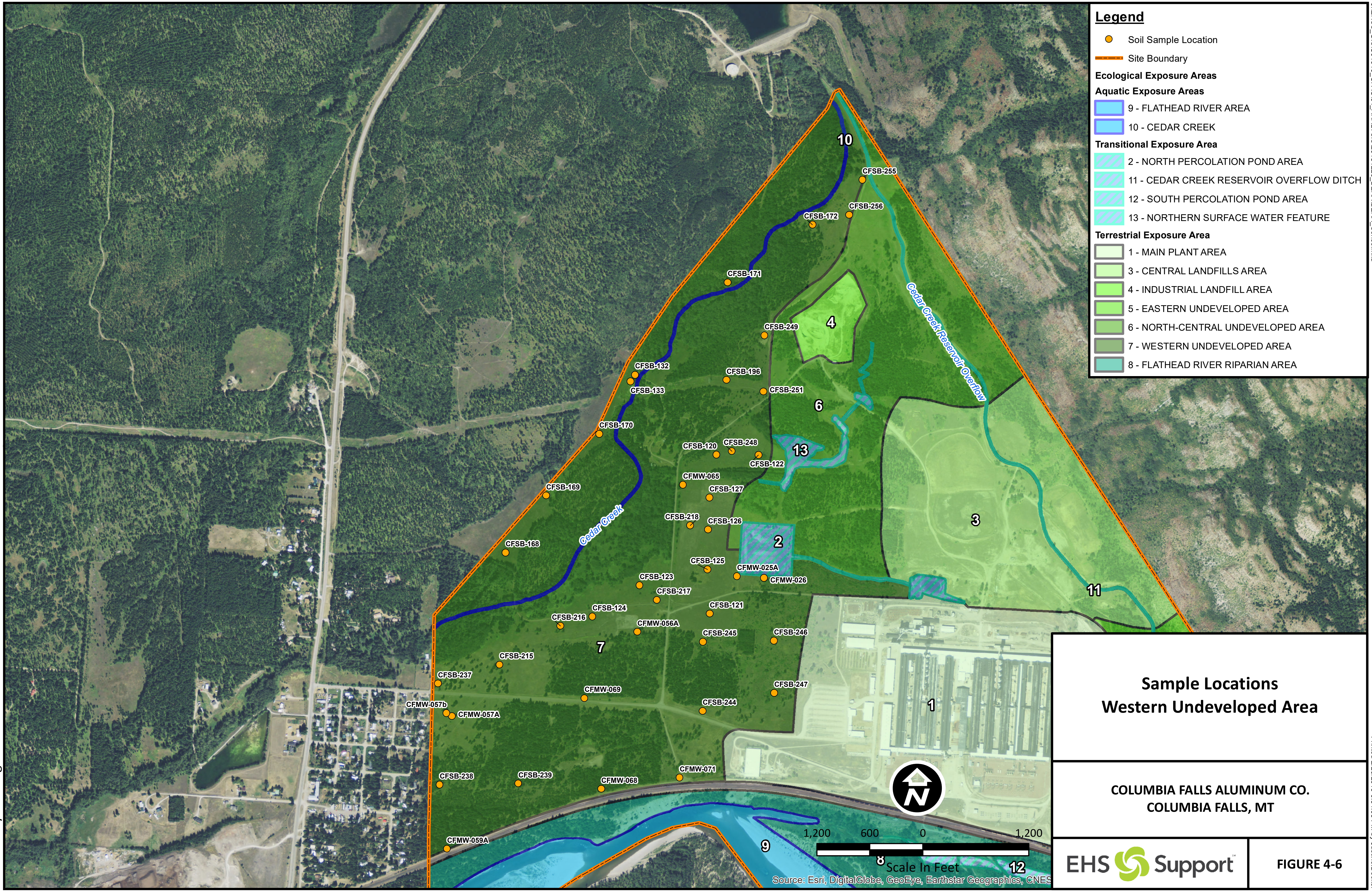

Sample Locations
Western Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-6

Reviewed By: G. Long

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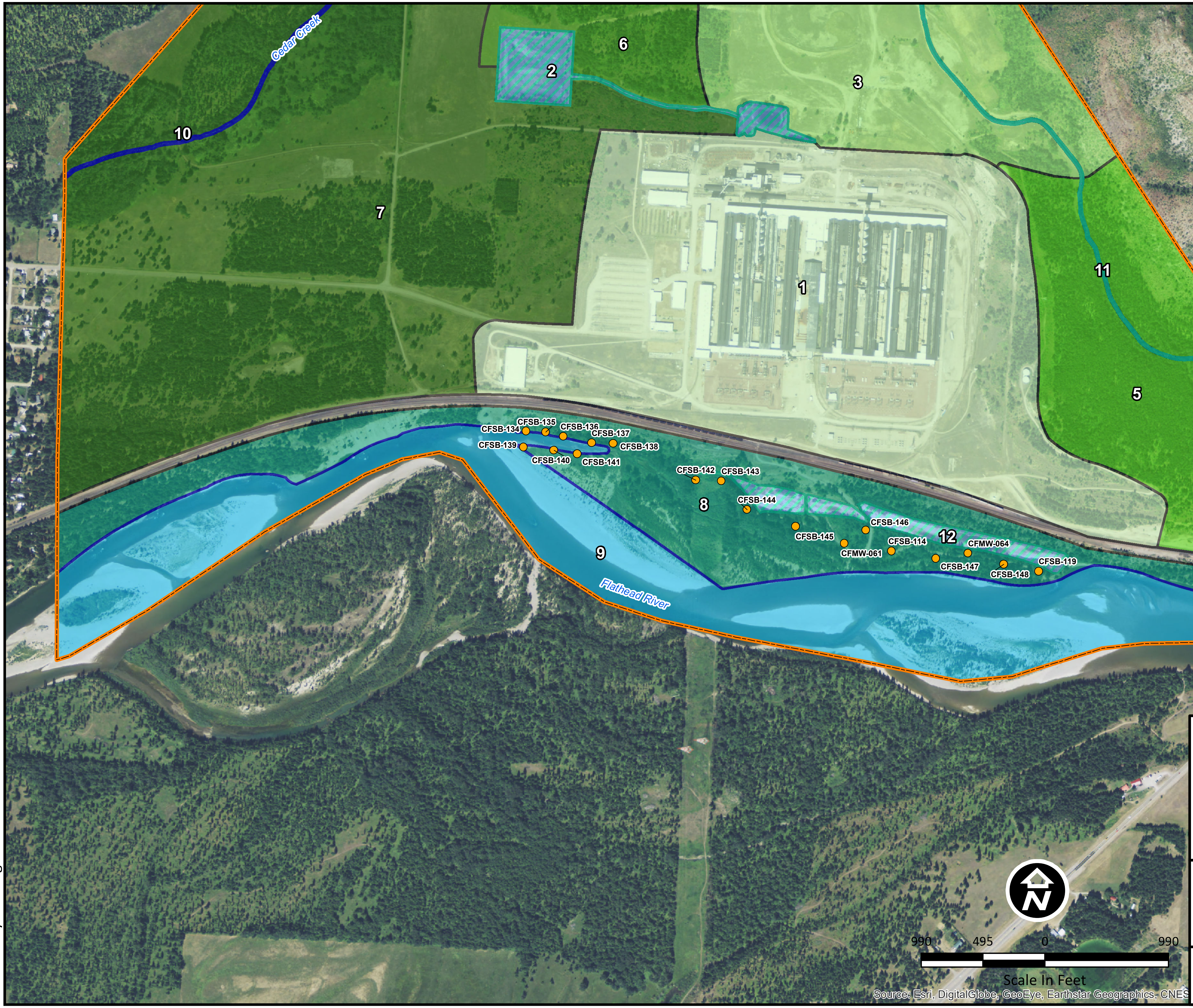

Sample Locations
Flathead River Riperian Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-7

Reviewed By: G. Long

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Incremental Sample Grids
Operational Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-8

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Sample Locations
North Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-9

Reviewed By: G. Long

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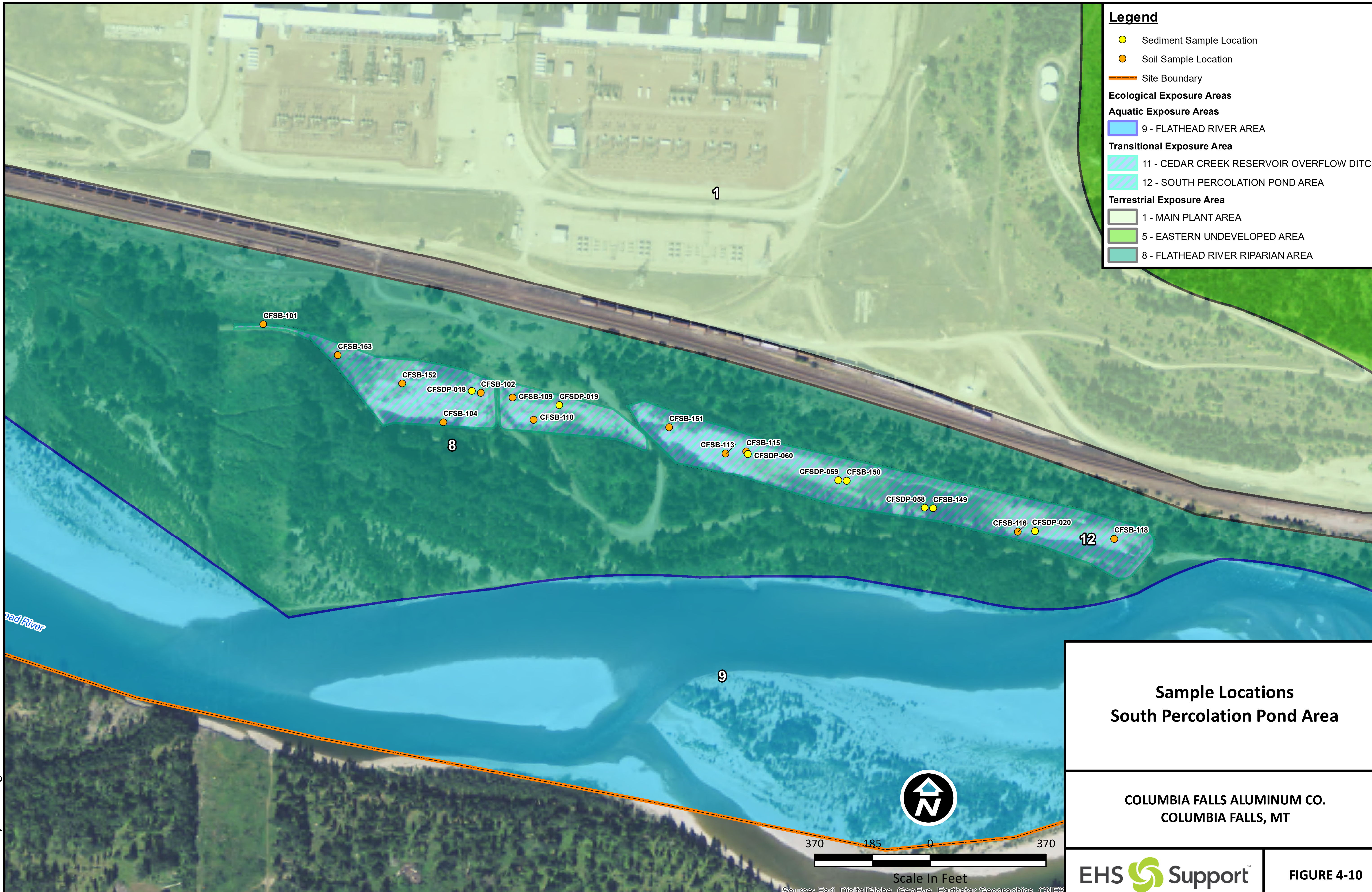

Sample Locations
South Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-10

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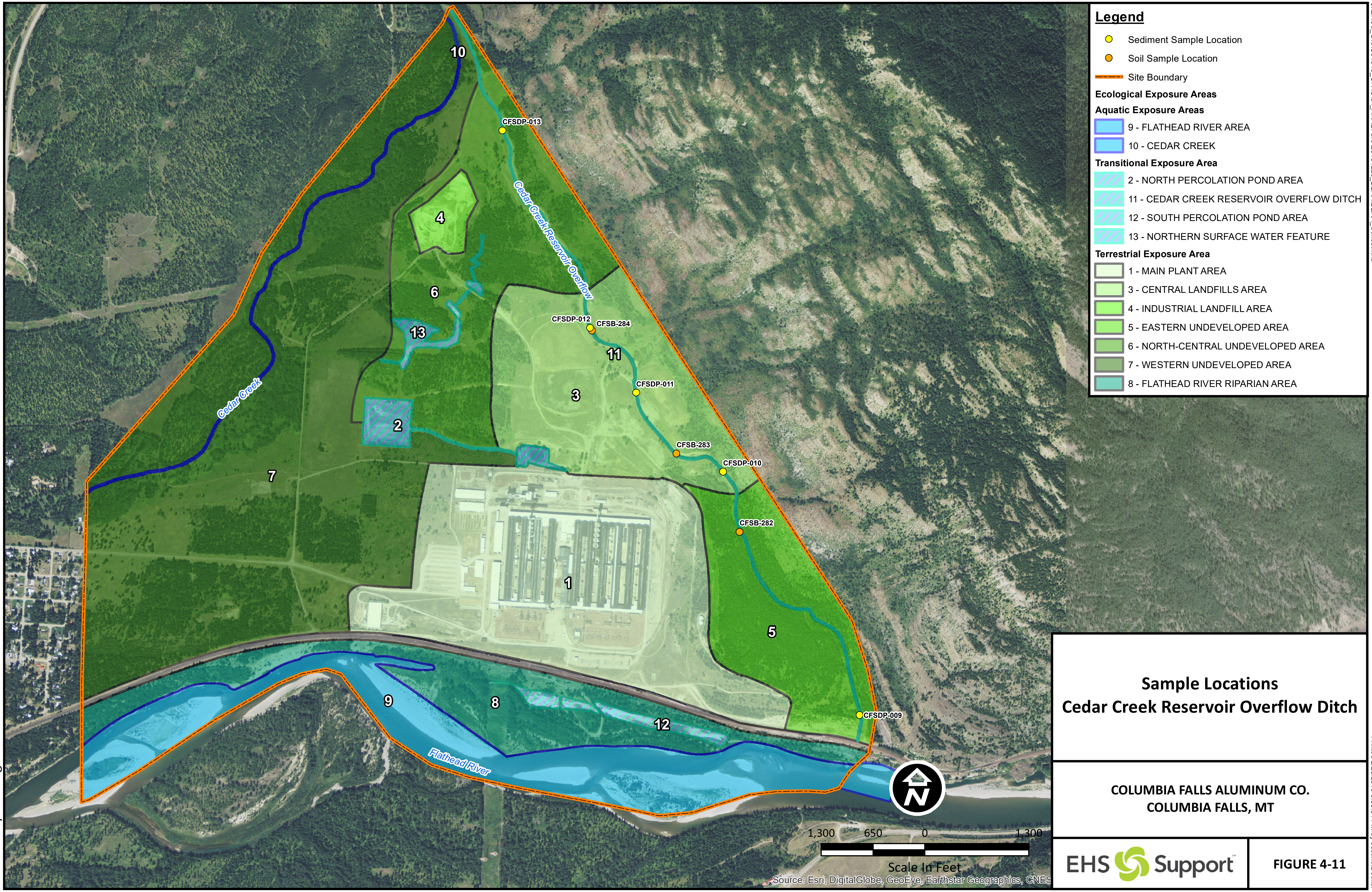

Sample Locations
Cedar Creek Reservoir Overflow Ditch

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-11

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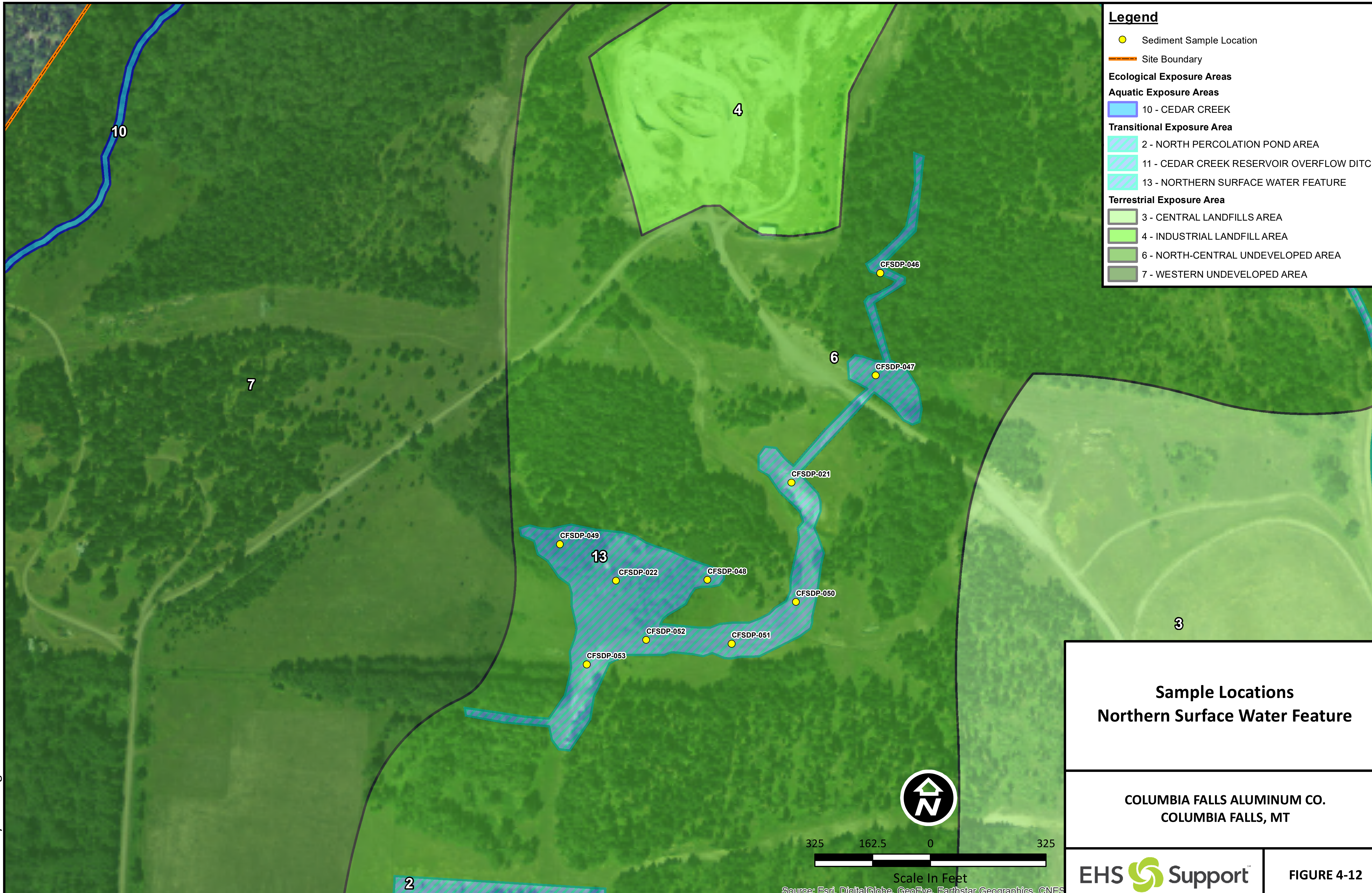

Sample Locations
Northern Surface Water Feature

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-12

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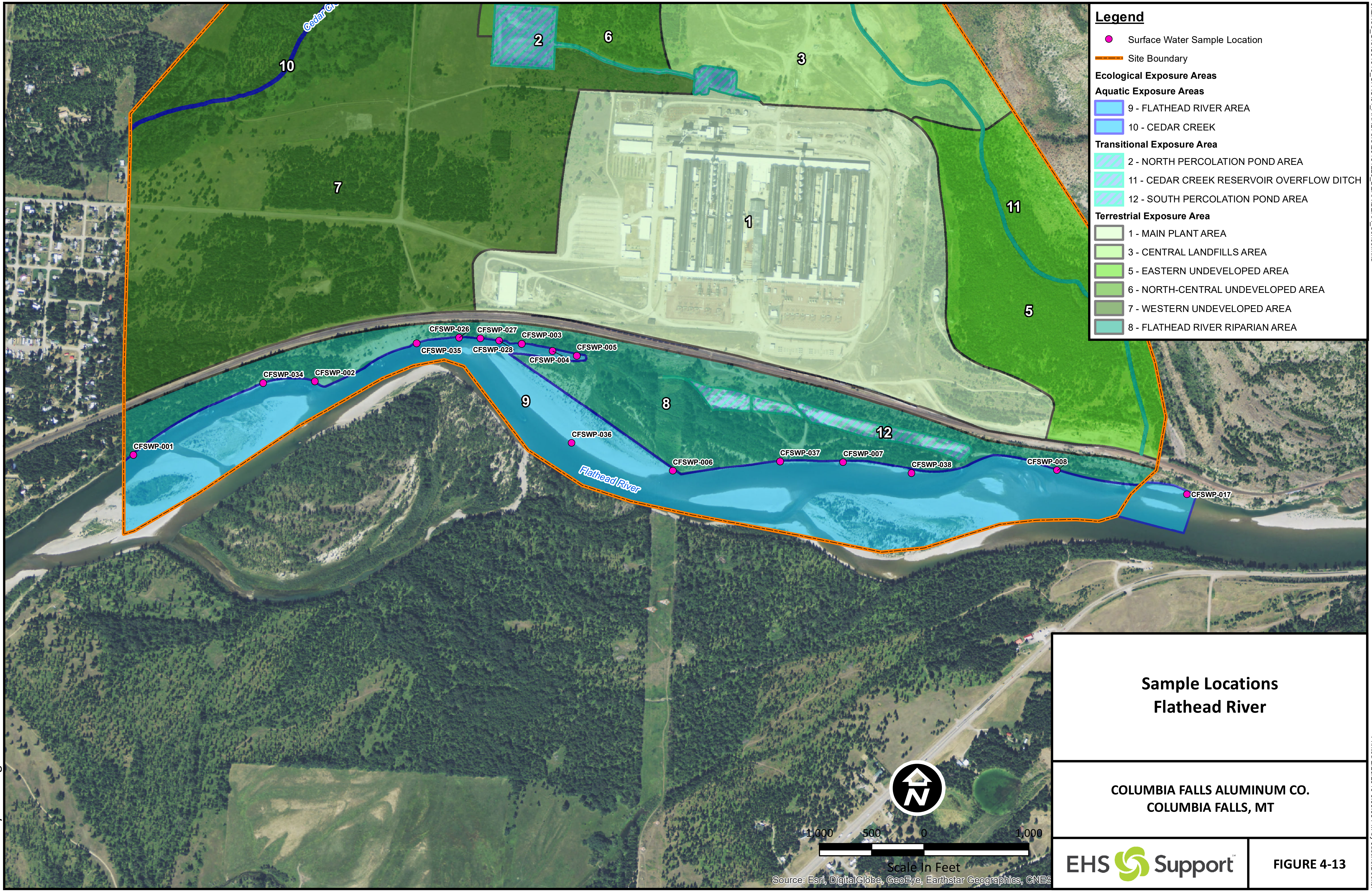

Sample Locations
Flathead River

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-13

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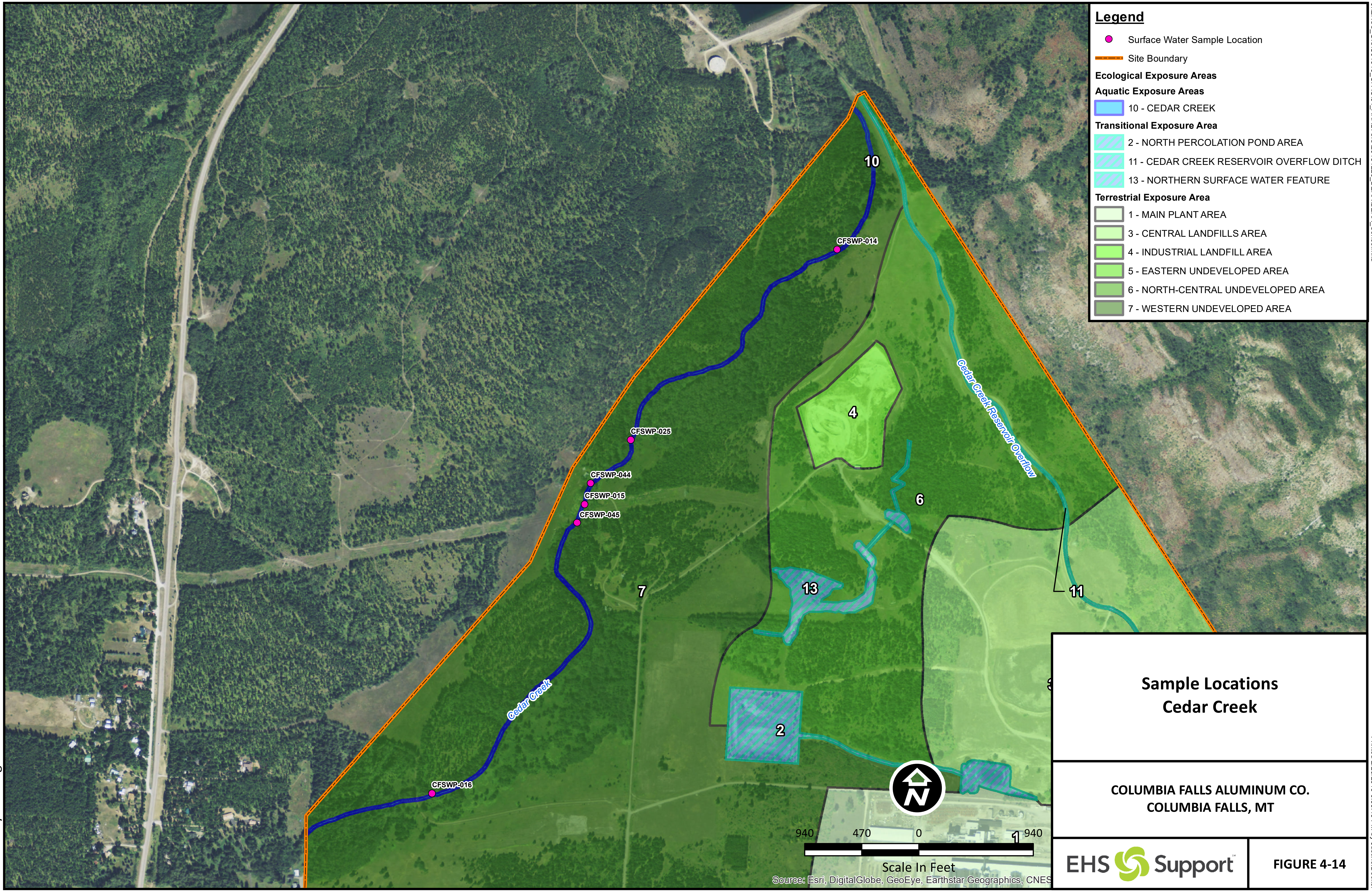

Sample Locations
Cedar Creek

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 4-14

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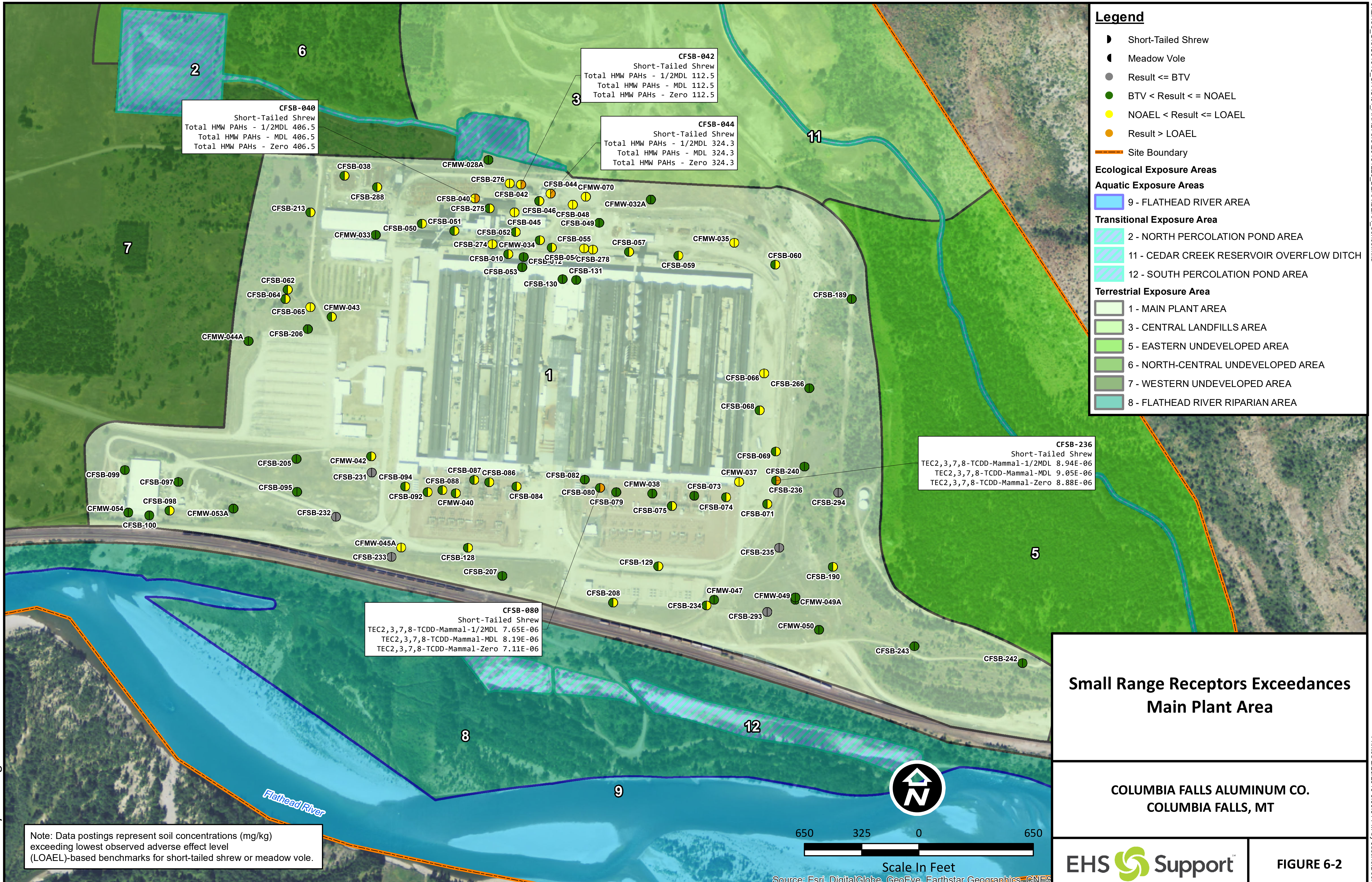
Soil NOEC/LOEC
Direct Contact Exceedances
Main Plant Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-1

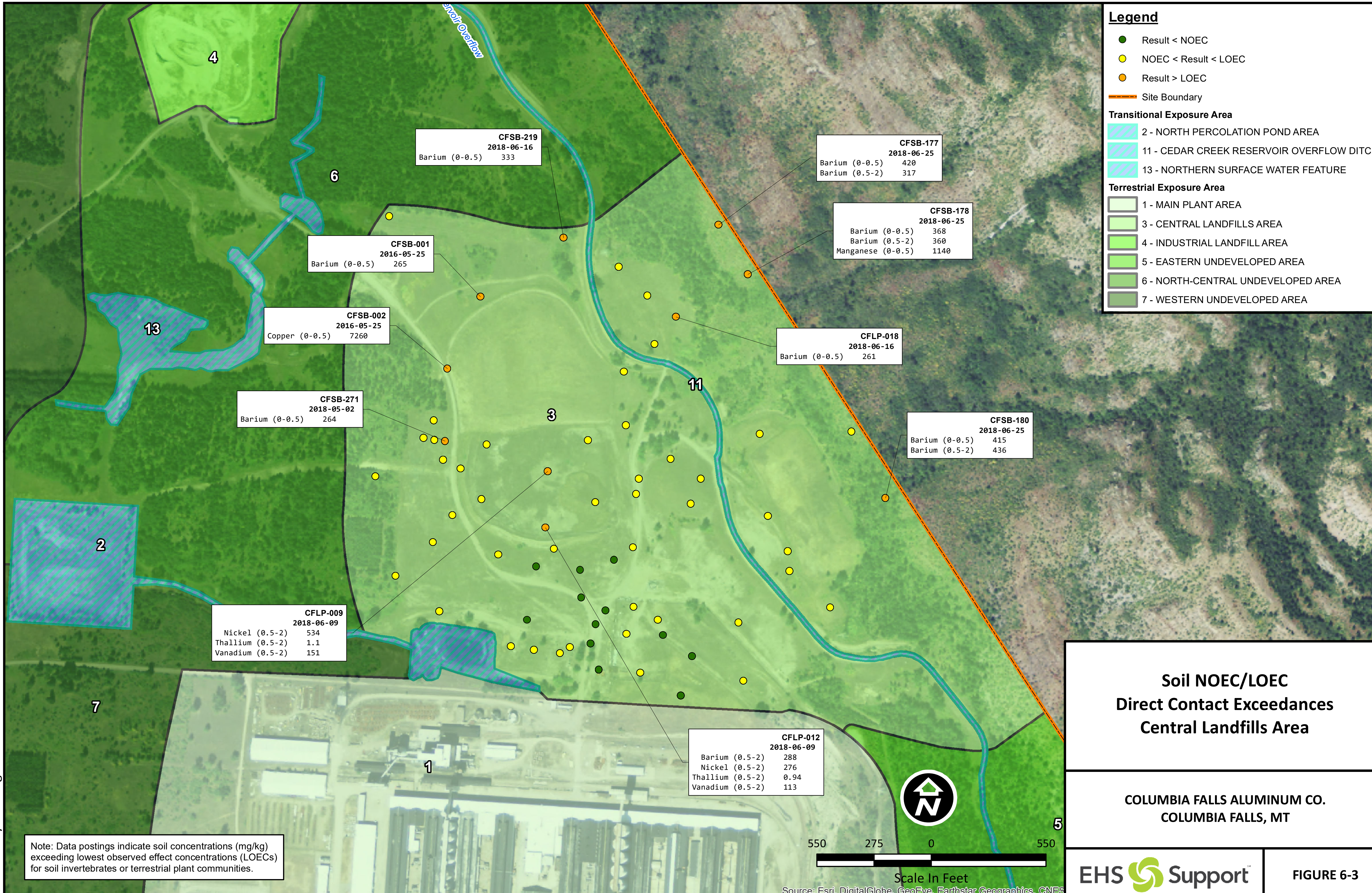


Small Range Receptors Exceedances
Main Plant Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-2



Reviewed By: G. Long

Soil NOEC/LOEC
Direct Contact Exceedances
Central Landfills Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-3

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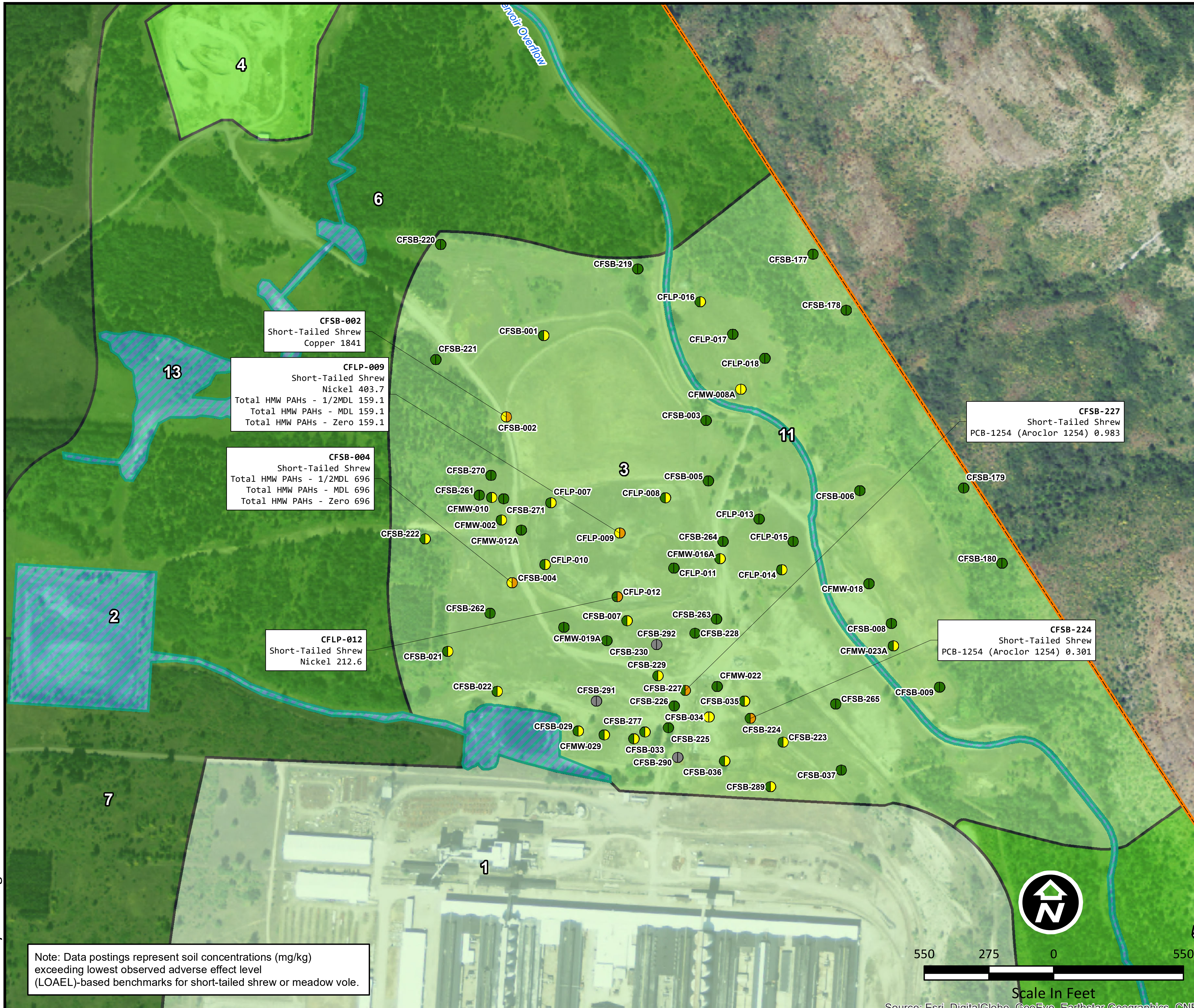

Legend

- Short-Tailed Shrew
- Meadow Vole
- Result <= BTV
- BTV < Result < = NOAEL
- NOAEL < Result <= LOAEL
- Result > LOAEL
- Site Boundary

Transitional Exposure Area

- 2 - NORTH PERCOLATION POND AREA
- 11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
- 13 - NORTHERN SURFACE WATER FEATURE

Terrestrial Exposure Area

- 1 - MAIN PLANT AREA
- 3 - CENTRAL LANDFILLS AREA
- 4 - INDUSTRIAL LANDFILL AREA
- 5 - EASTERN UNDEVELOPED AREA
- 6 - NORTH-CENTRAL UNDEVELOPED AREA
- 7 - WESTERN UNDEVELOPED AREA

Note: Data postings represent soil concentrations (mg/kg) exceeding lowest observed adverse effect level (LOAEL)-based benchmarks for short-tailed shrew or meadow vole.

Reviewed By: G. Long

Small Range Receptors Exceedances Central Landfills Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-4

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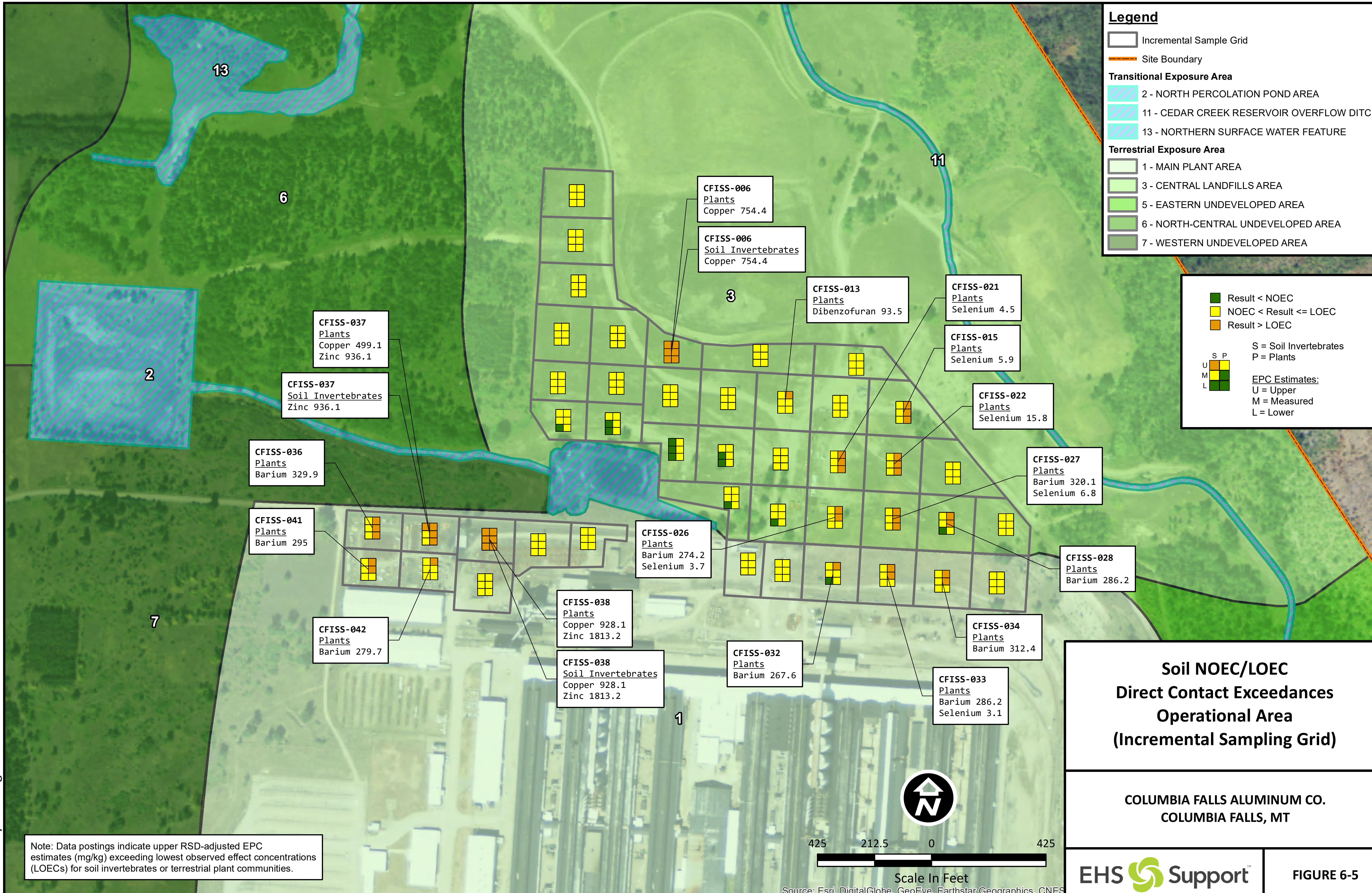

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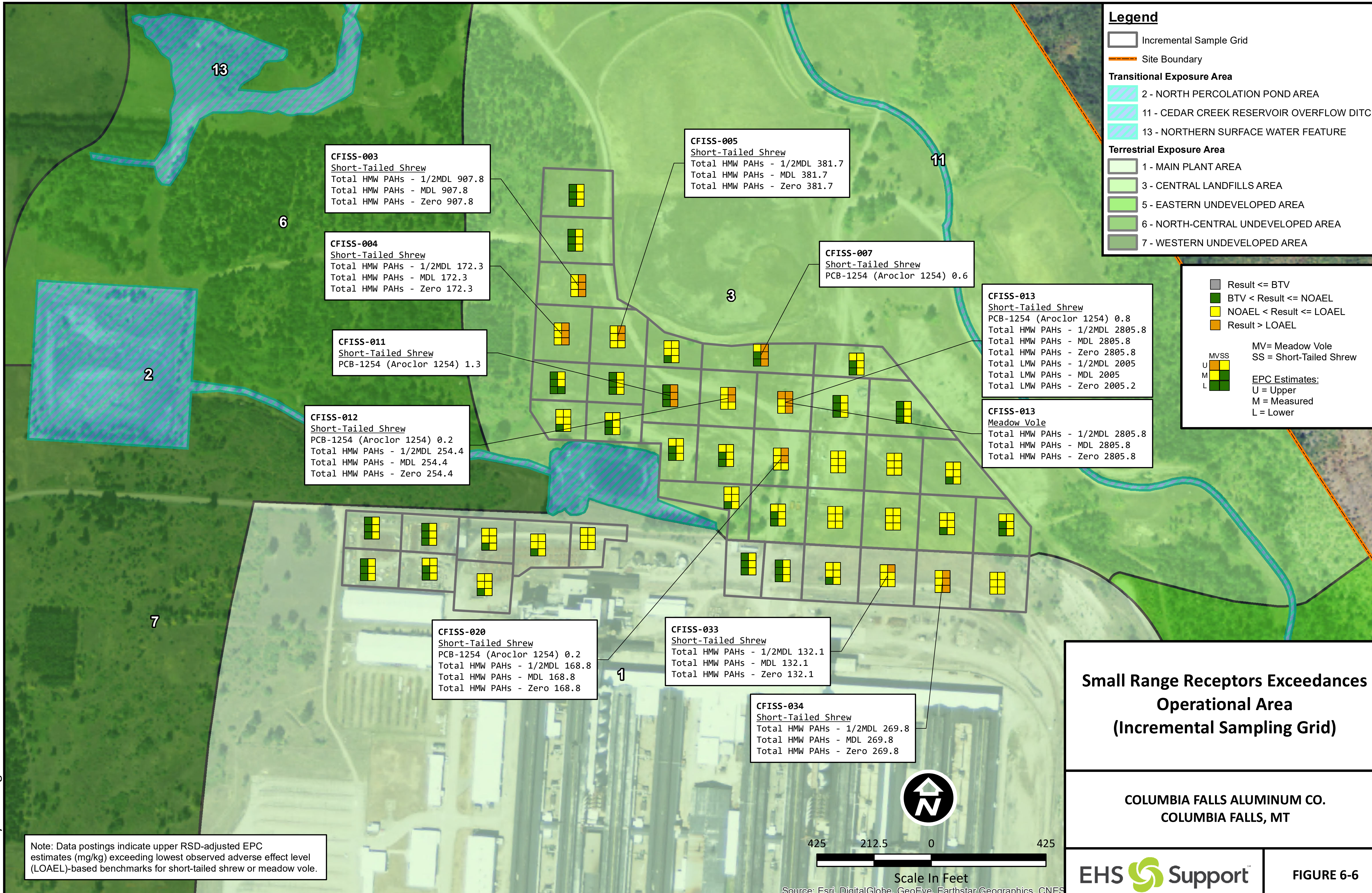

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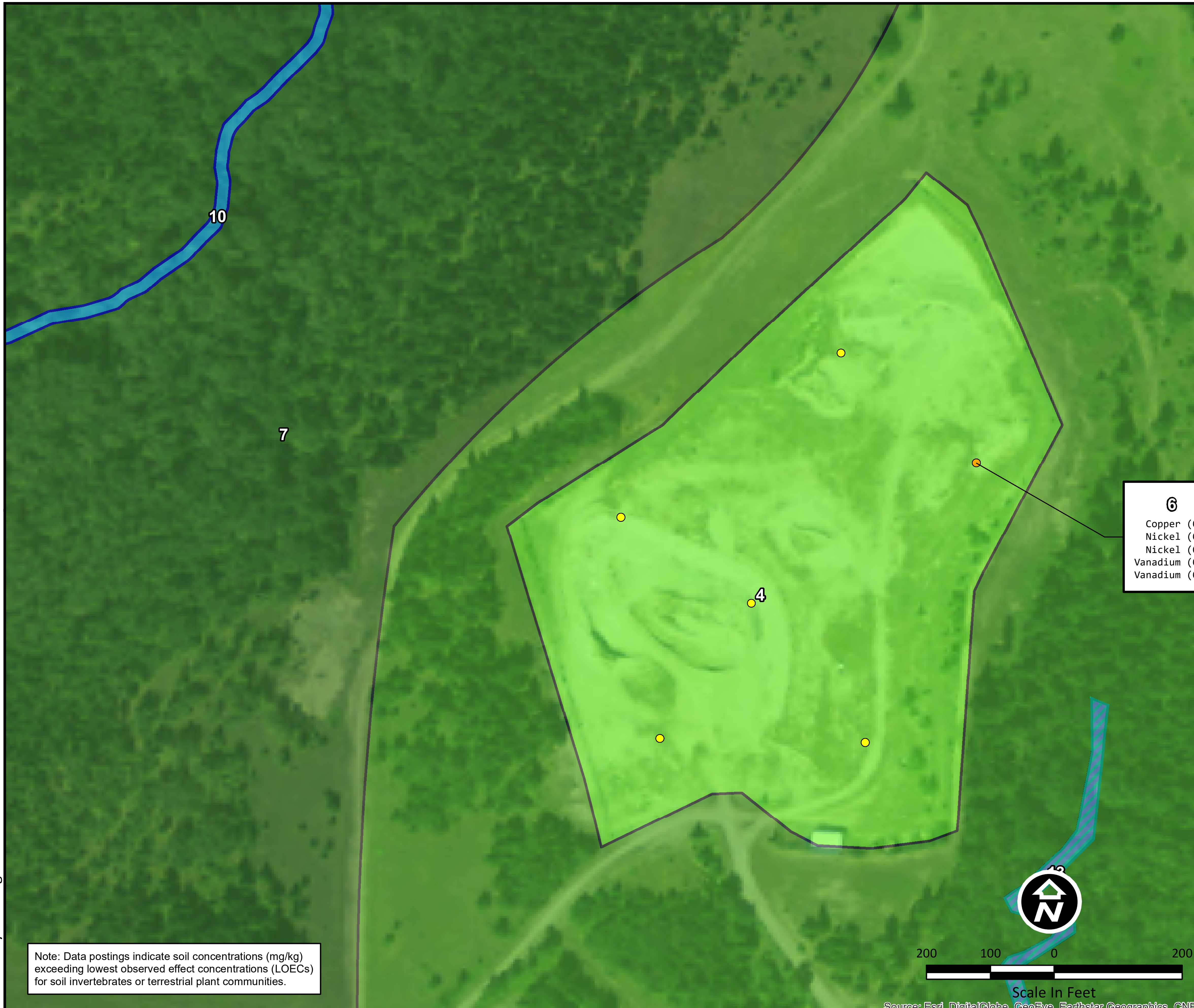

Soil NOEC/LOEC Direct Contact Exceedances Industrial Landfill

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-7

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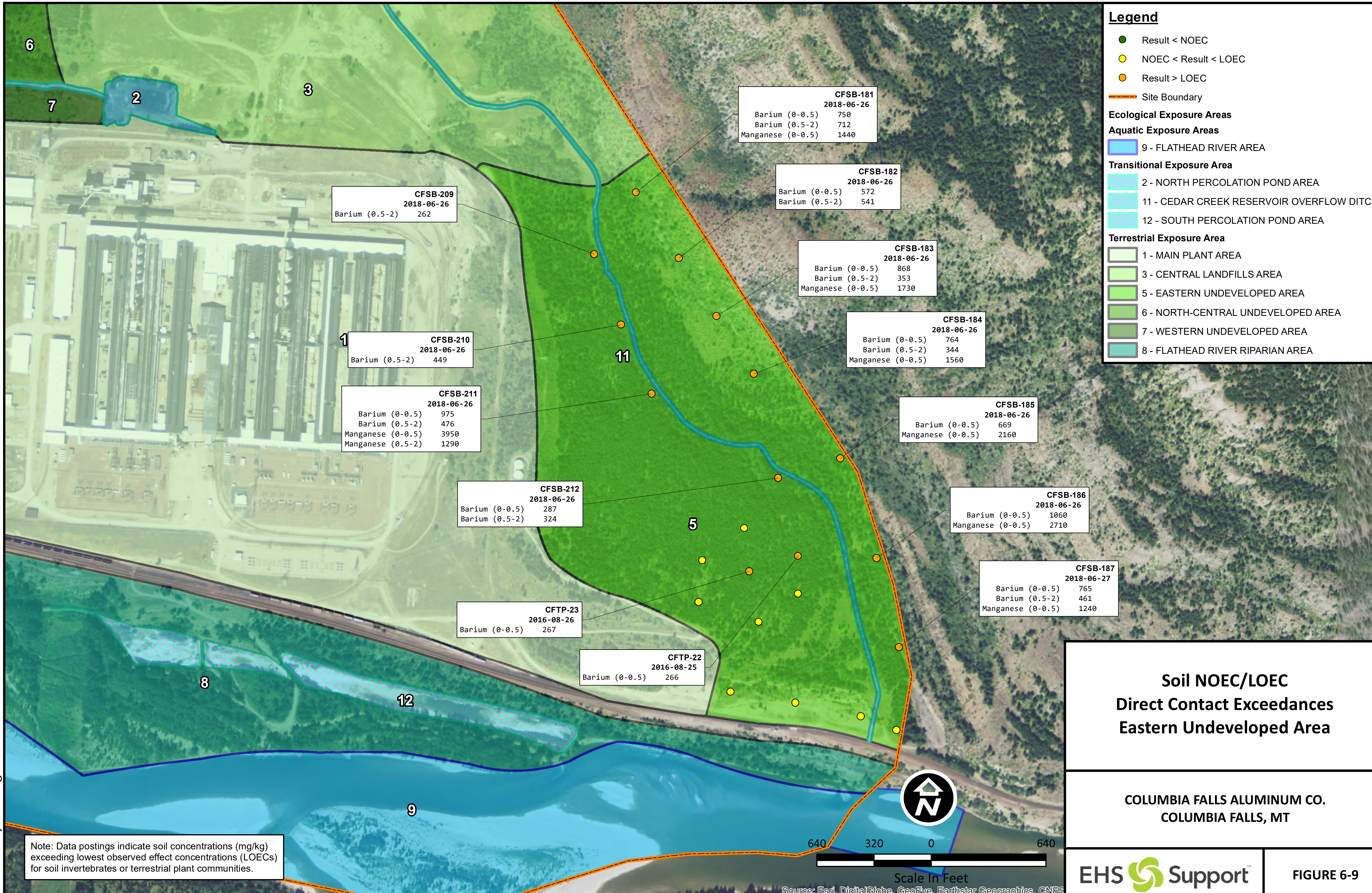
Small Range Receptors Exceedances Industrial Landfill

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-8

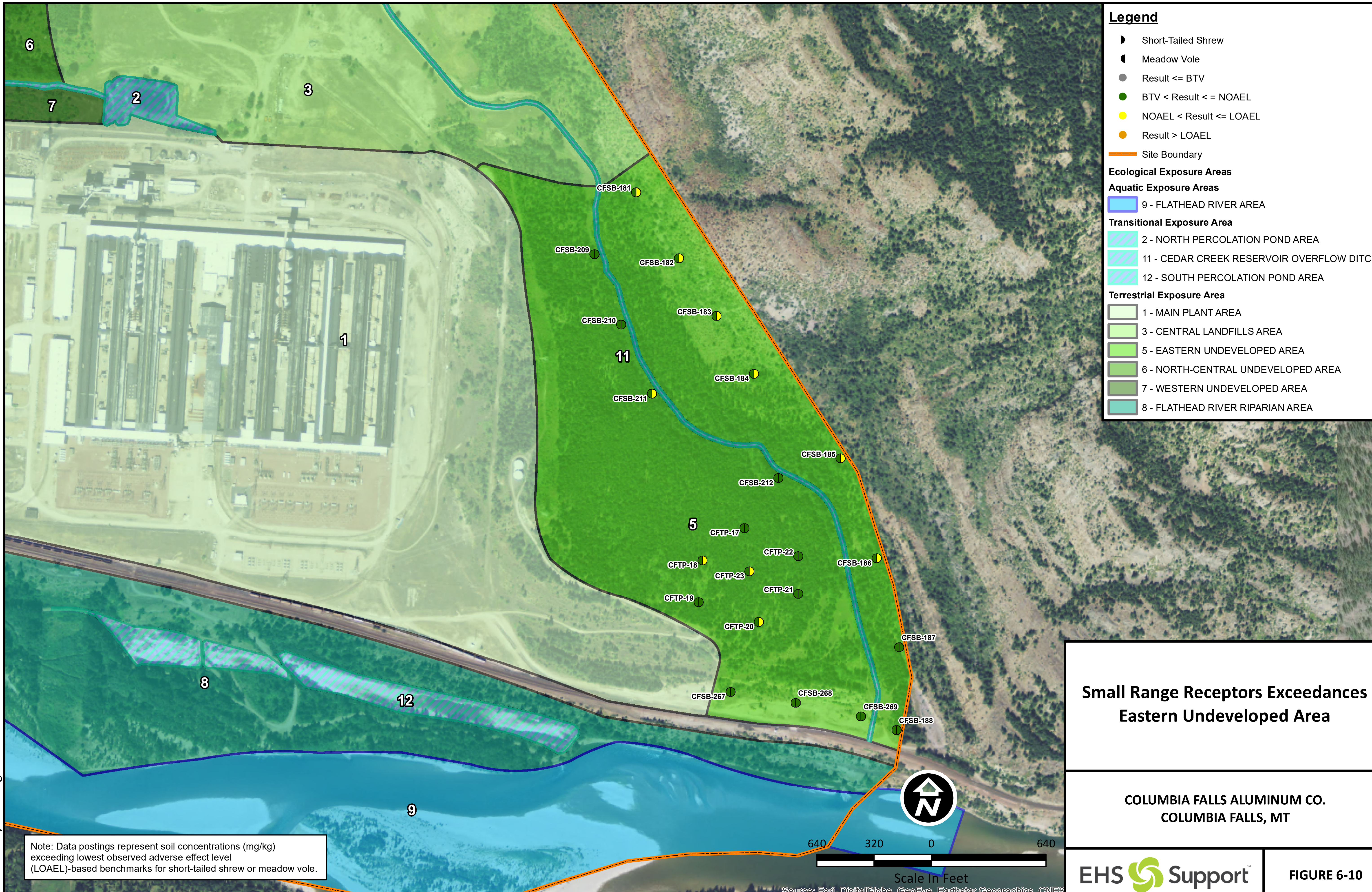


Soil NOEC/LOEC Direct Contact Exceedances Eastern Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-9



Small Range Receptors Exceedances Eastern Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-10

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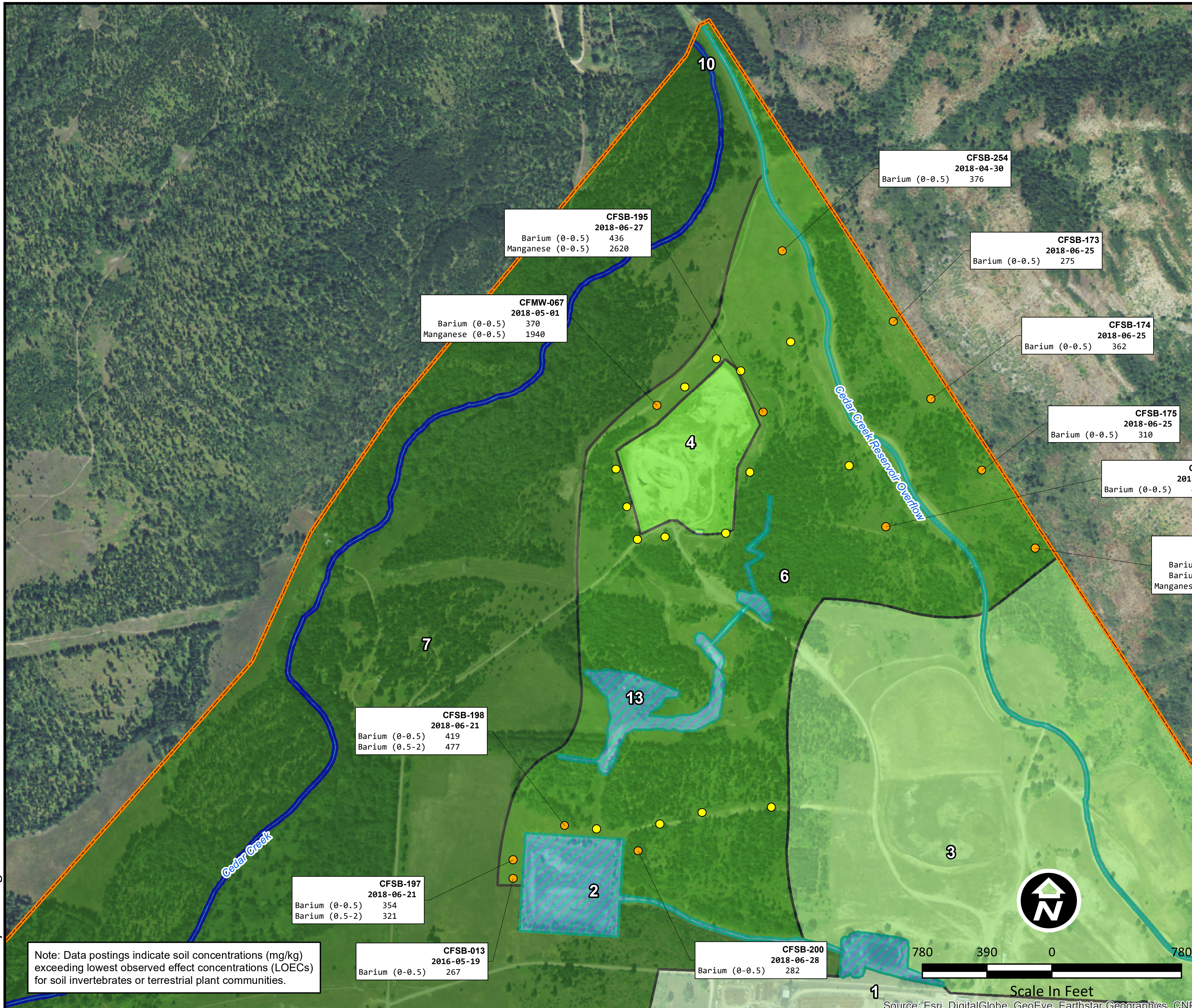

Soil NOEC/LOEC Direct Contact Exceedances North-Central Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-11

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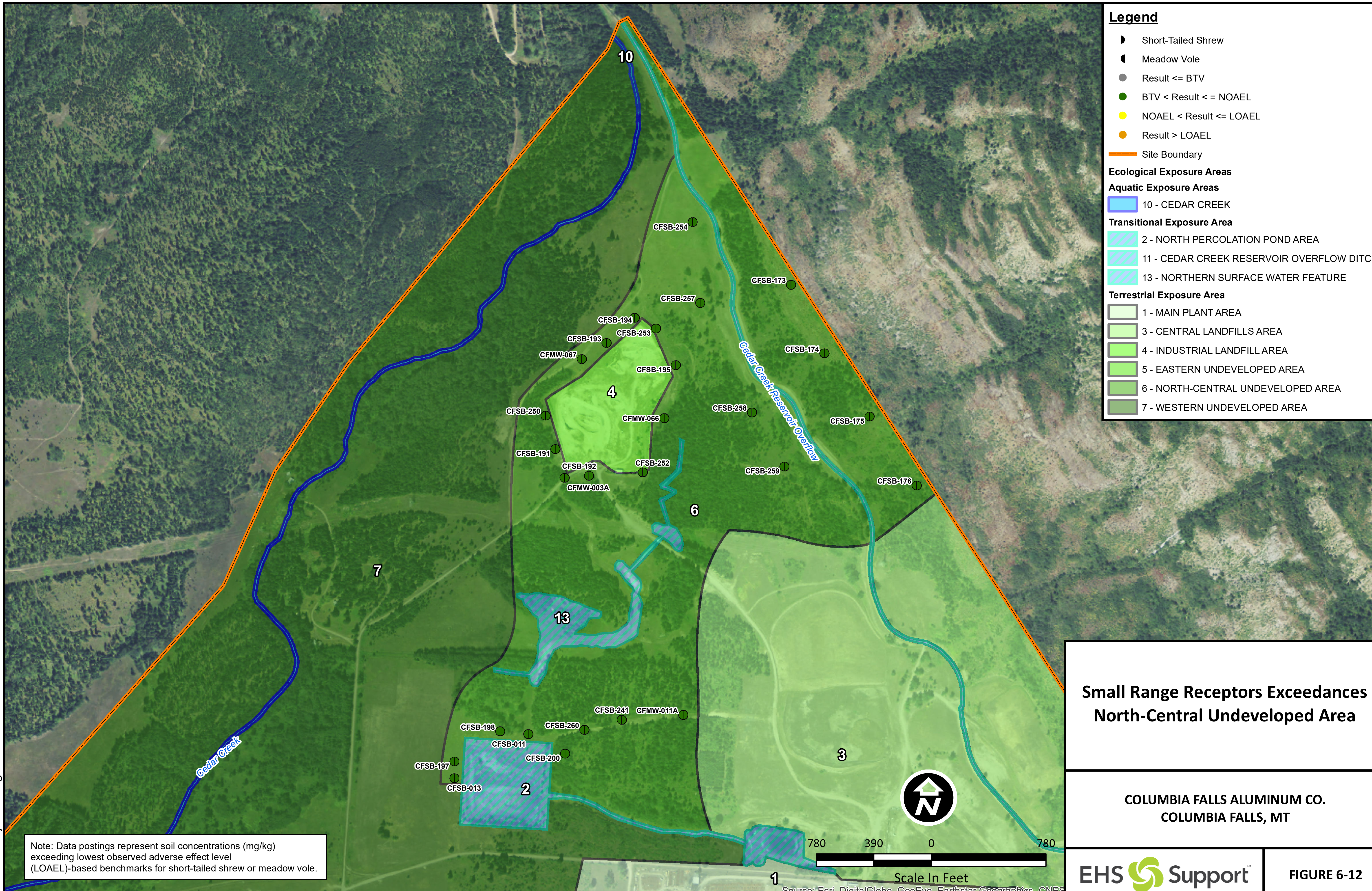
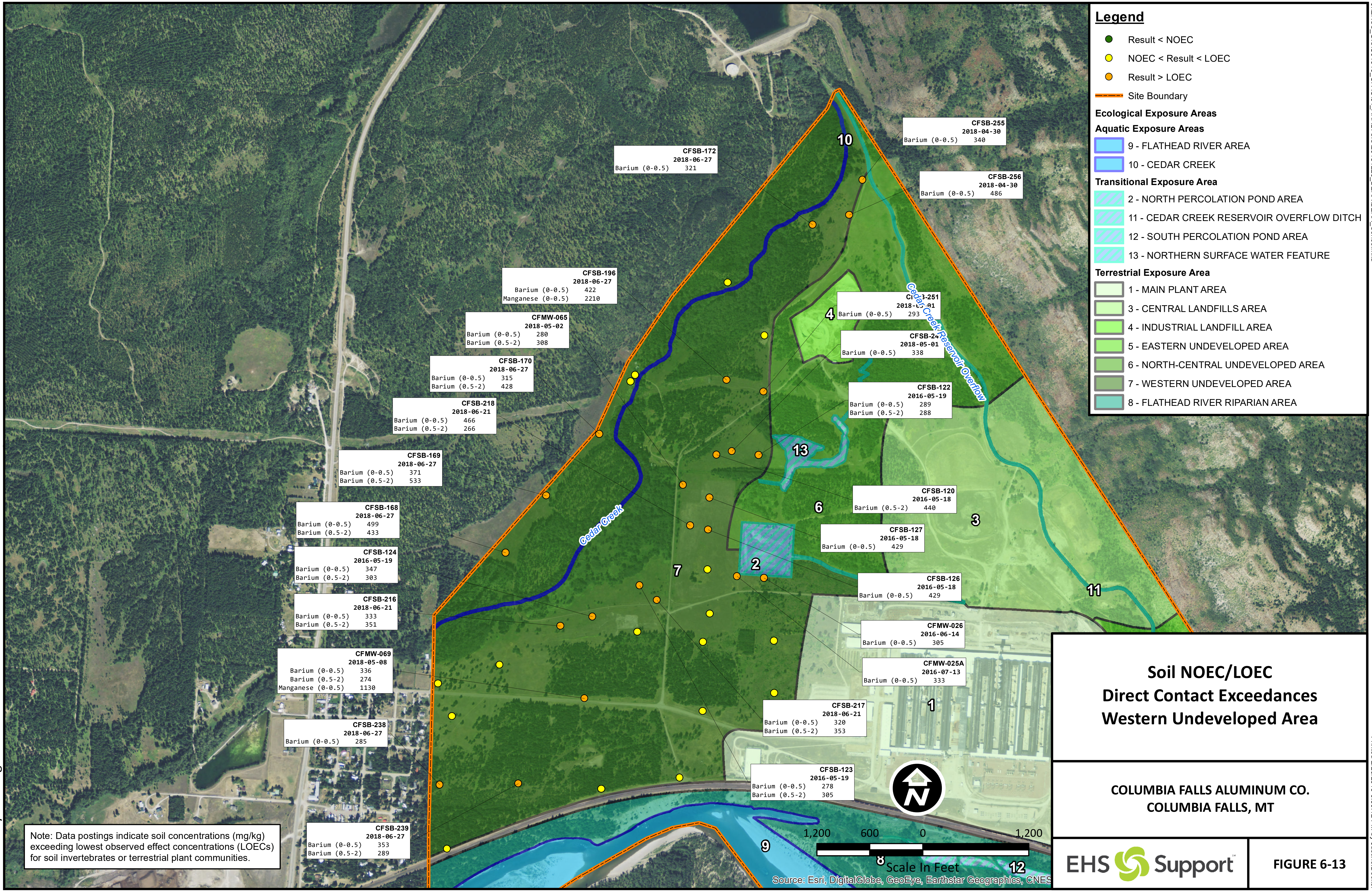


Small Range Receptors Exceedances North-Central Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-12



Note: Data postings indicate soil concentrations (mg/kg) exceeding lowest observed effect concentrations (LOECs) for soil invertebrates or terrestrial plant communities.

Soil NOEC/LOEC Direct Contact Exceedances Western Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-13

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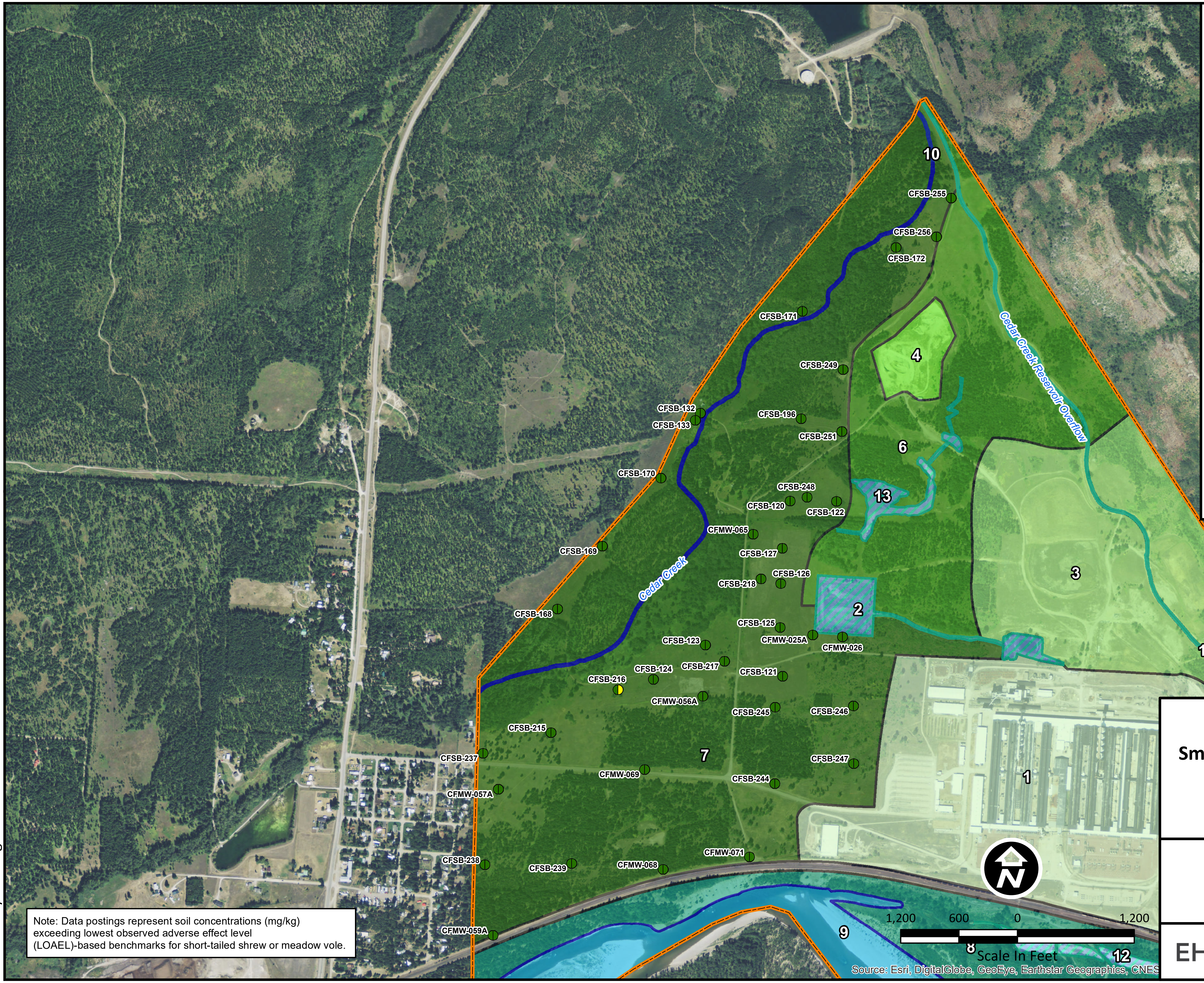

Note: Data postings represent soil concentrations (mg/kg) exceeding lowest observed adverse effect level (LOAEL)-based benchmarks for short-tailed shrew or meadow vole.

Legend

- Short-Tailed Shrew
- Meadow Vole
- Result <= BTV
- BTV < Result < = NOAEL
- NOAEL < Result <= LOAEL
- Result > LOAEL
- Site Boundary

Ecological Exposure Areas

Aquatic Exposure Areas

- 9 - FLATHEAD RIVER AREA
- 10 - CEDAR CREEK

Transitional Exposure Area

- 2 - NORTH PERCOLATION POND AREA
- 11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
- 12 - SOUTH PERCOLATION POND AREA
- 13 - NORTHERN SURFACE WATER FEATURE

Terrestrial Exposure Area

- 1 - MAIN PLANT AREA
- 3 - CENTRAL LANDFILLS AREA
- 4 - INDUSTRIAL LANDFILL AREA
- 5 - EASTERN UNDEVELOPED AREA
- 6 - NORTH-CENTRAL UNDEVELOPED AREA
- 7 - WESTERN UNDEVELOPED AREA
- 8 - FLATHEAD RIVER RIPARIAN AREA

Small Range Receptors Exceedances Western Undeveloped Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-14

Reviewed By: G. Long

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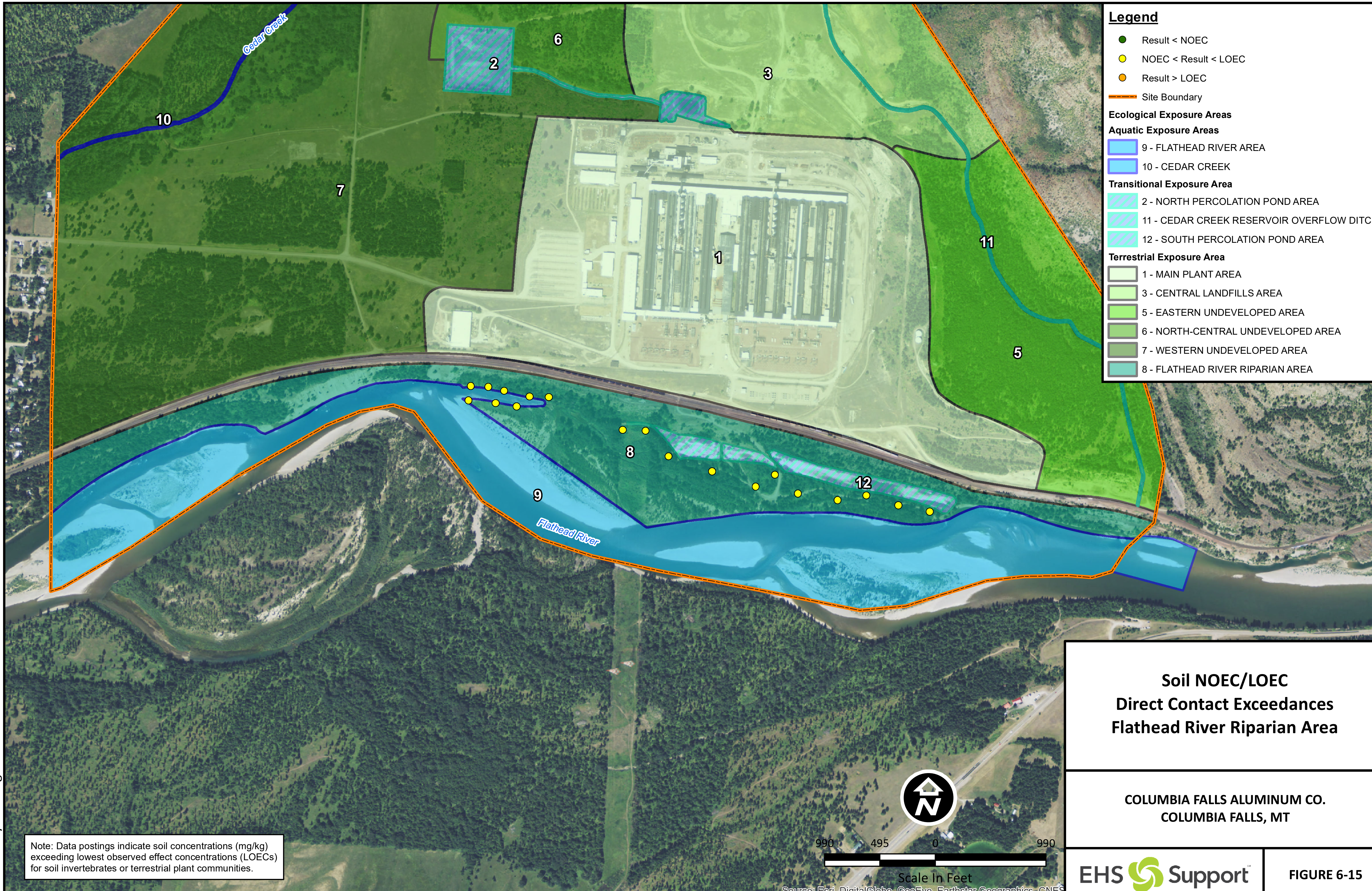

Note: Data postings indicate soil concentrations (mg/kg) exceeding lowest observed effect concentrations (LOECs) for soil invertebrates or terrestrial plant communities.

Soil NOEC/LOEC Direct Contact Exceedances Flathead River Riparian Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-15

Reviewed By: G. Long

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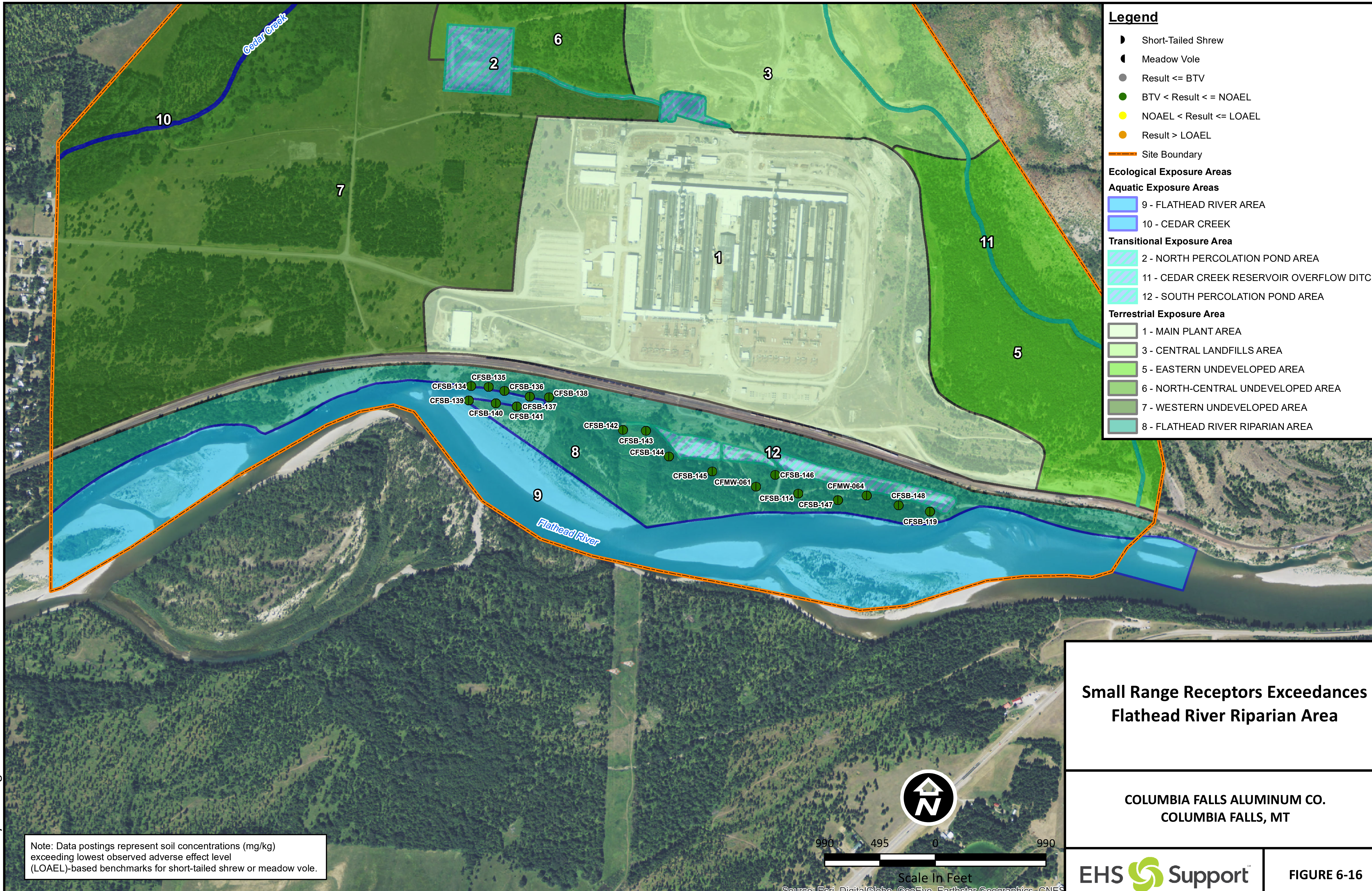
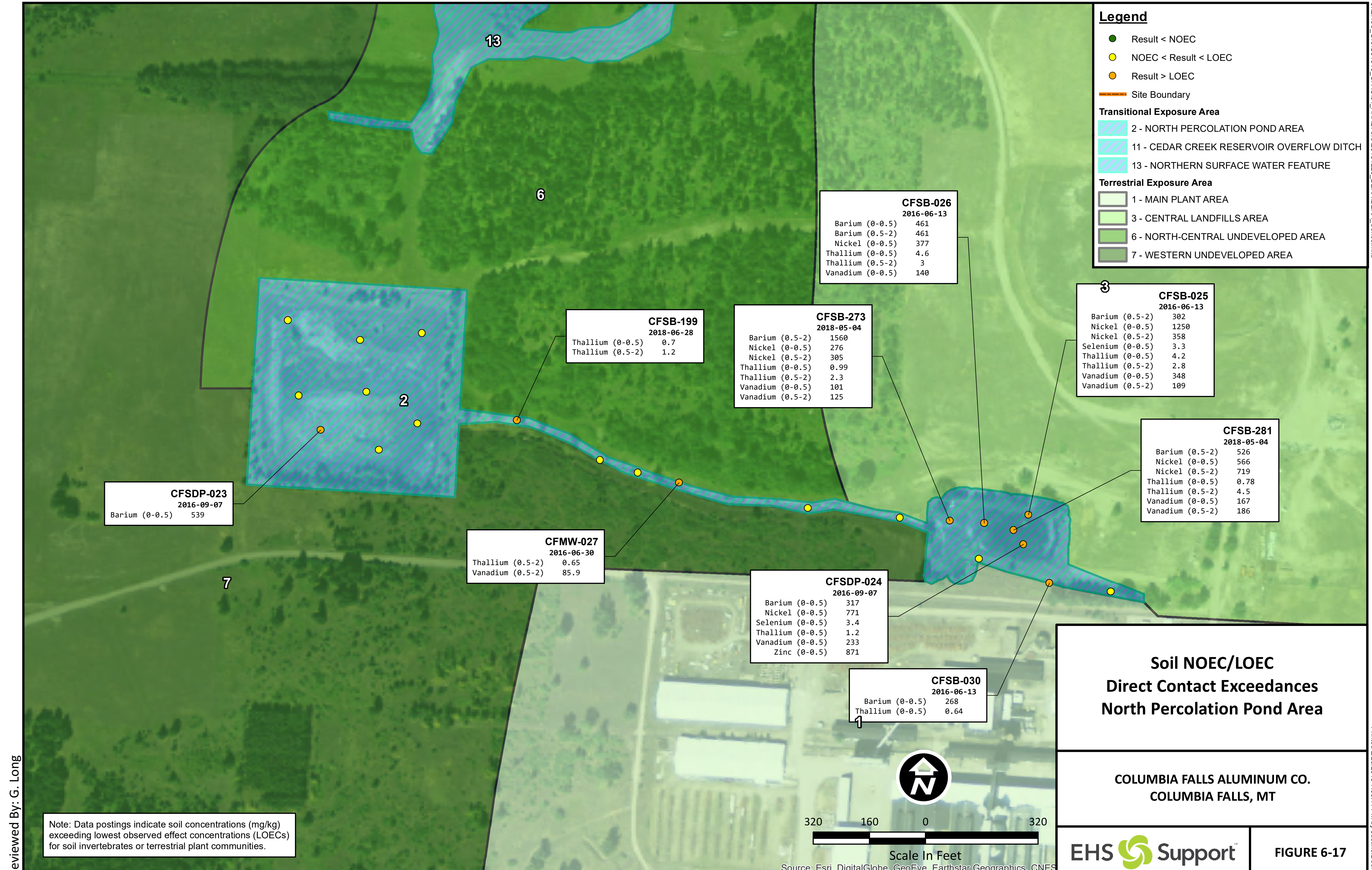


Small Range Receptors Exceedances Flathead River Riparian Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-16


Legend
Result < NOEC
NOEC < Result < LOEC
Result > LOEC
Site Boundary
Transitional Exposure Area
2 - NORTH PERCOLATION POND AREA
11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
13 - NORTHERN SURFACE WATER FEATURE
Terrestrial Exposure Area
1 - MAIN PLANT AREA
3 - CENTRAL LANDFILLS AREA
6 - NORTH-CENTRAL UNDEVELOPED AREA
7 - WESTERN UNDEVELOPED AREA
13
6
2
7
3
1
CFSB-026
2016-06-13
Barium (0-0.5) 461
Barium (0.5-2) 461
Nickel (0-0.5) 377
Thallium (0-0.5) 4.6
Thallium (0.5-2) 3
Vanadium (0-0.5) 140
CFSB-199
2018-06-28
Thallium (0-0.5) 0.7
Thallium (0.5-2) 1.2
CFSB-273
2018-05-04
Barium (0.5-2) 1560
Nickel (0-0.5) 276
Nickel (0.5-2) 305
Thallium (0-0.5) 0.99
Thallium (0.5-2) 2.3
Vanadium (0-0.5) 101
Vanadium (0.5-2) 125
CFSB-025
2016-06-13
Barium (0.5-2) 302
Nickel (0-0.5) 1250
Nickel (0.5-2) 358
Selenium (0-0.5) 3.3
Thallium (0-0.5) 4.2
Thallium (0.5-2) 2.8
Vanadium (0-0.5) 348
Vanadium (0.5-2) 109
CFSB-281
2018-05-04
Barium (0.5-2) 526
Nickel (0-0.5) 566
Nickel (0.5-2) 719
Thallium (0-0.5) 0.78
Thallium (0.5-2) 4.5
Vanadium (0-0.5) 167
Vanadium (0.5-2) 186
CFSDP-023
2016-09-07
Barium (0-0.5) 539
CFMW-027
2016-06-30
Thallium (0.5-2) 0.65
Vanadium (0.5-2) 85.9
CFSDP-024
2016-09-07
Barium (0-0.5) 317
Nickel (0-0.5) 771
Selenium (0-0.5) 3.4
Thallium (0-0.5) 1.2
Vanadium (0-0.5) 233
Zinc (0-0.5) 871
CFSB-030
2016-06-13
Barium (0-0.5) 268
Thallium (0-0.5) 0.64
N
320 160 0 320
Scale In Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES
Note: Data postings indicate soil concentrations (mg/kg) exceeding lowest observed effect concentrations (LOECs) for soil invertebrates or terrestrial plant communities.
Soil NOEC/LOEC
Direct Contact Exceedances
North Percolation Pond Area
COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT
EHS Support
FIGURE 6-17
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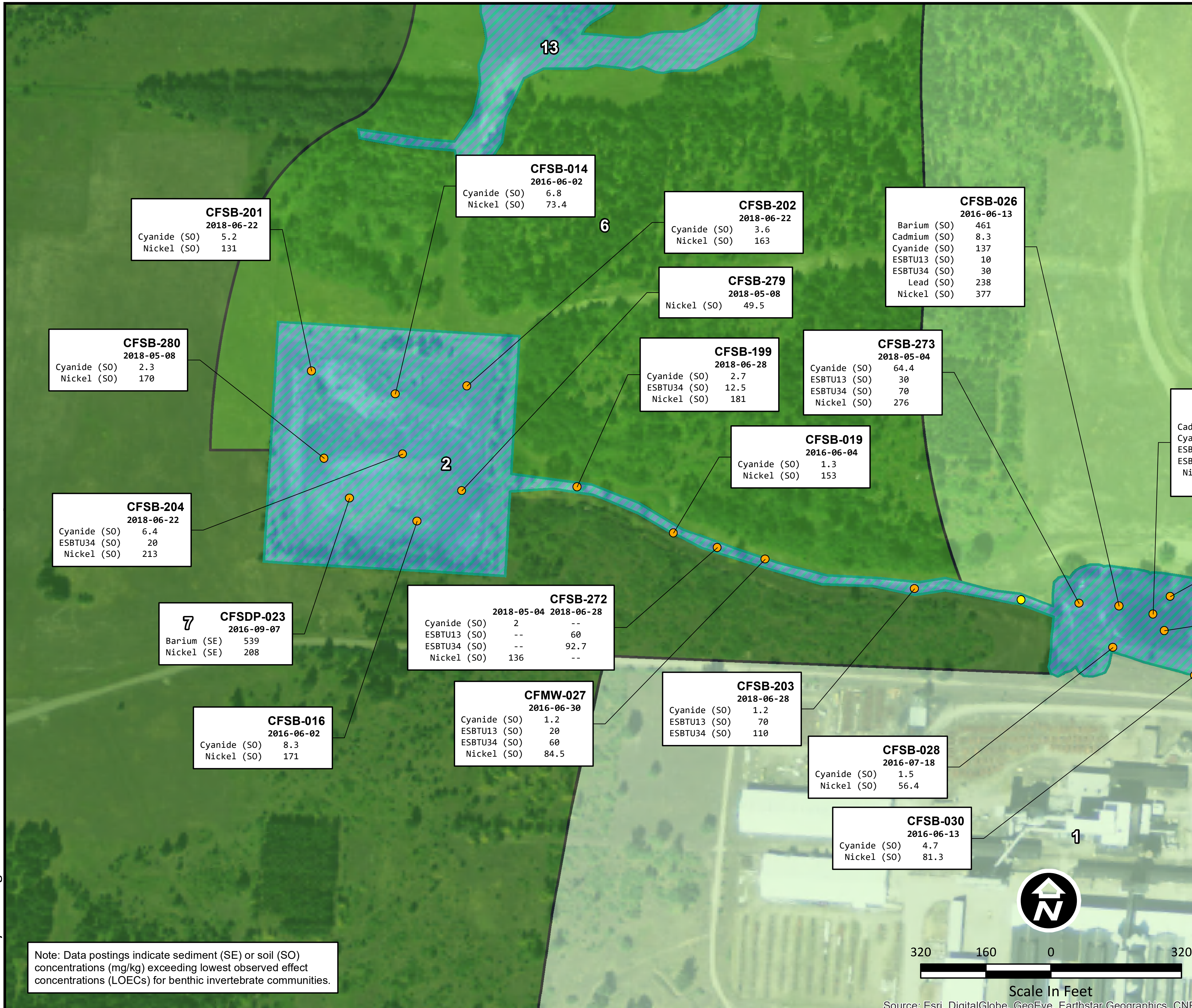

Sediment
NOEC/LOEC
Direct Contact Exceedances
North Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-18

Reviewed By: G. Long

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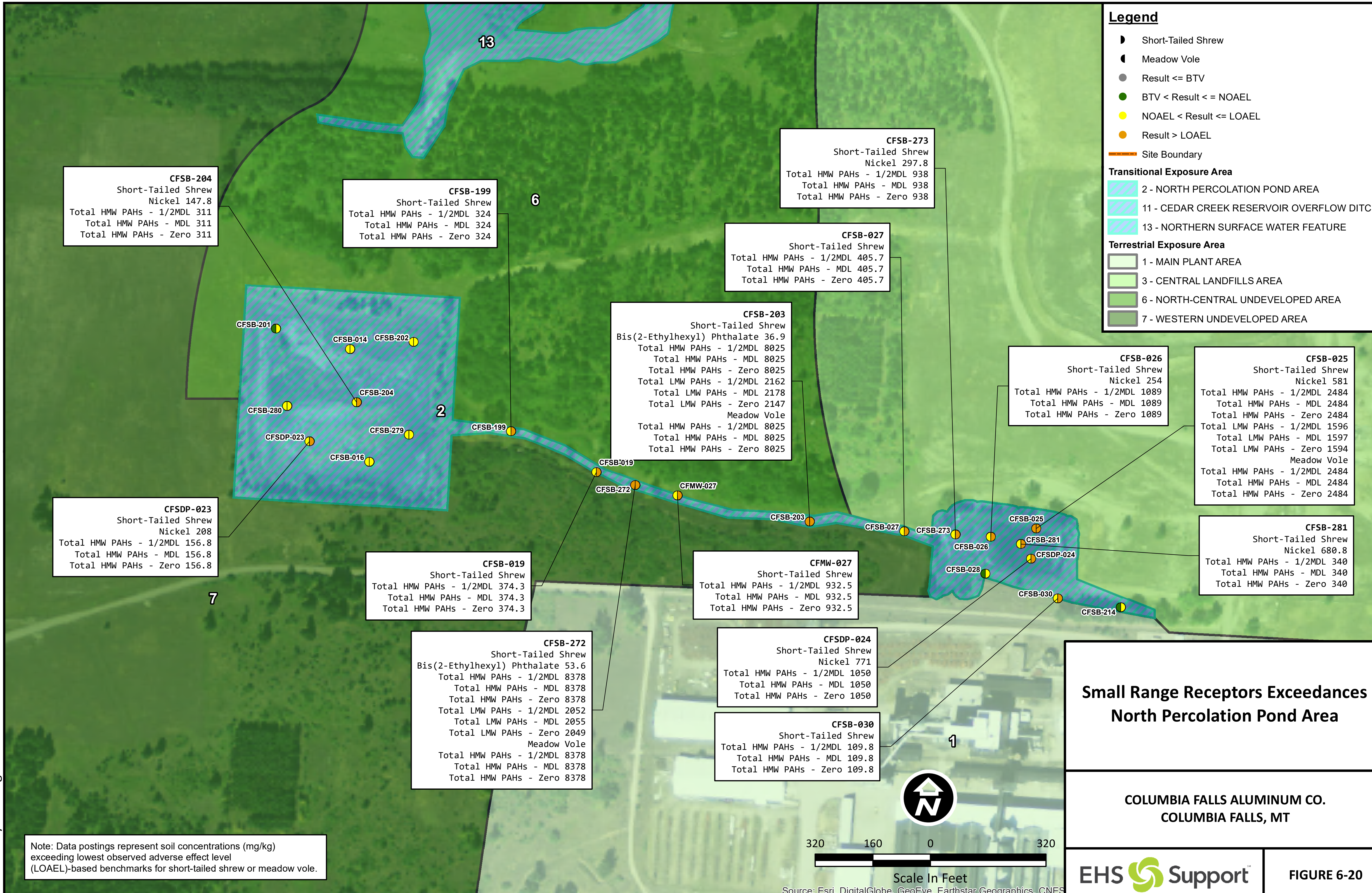

Small Range Receptors Exceedances North Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-20

Reviewed By: G. Long

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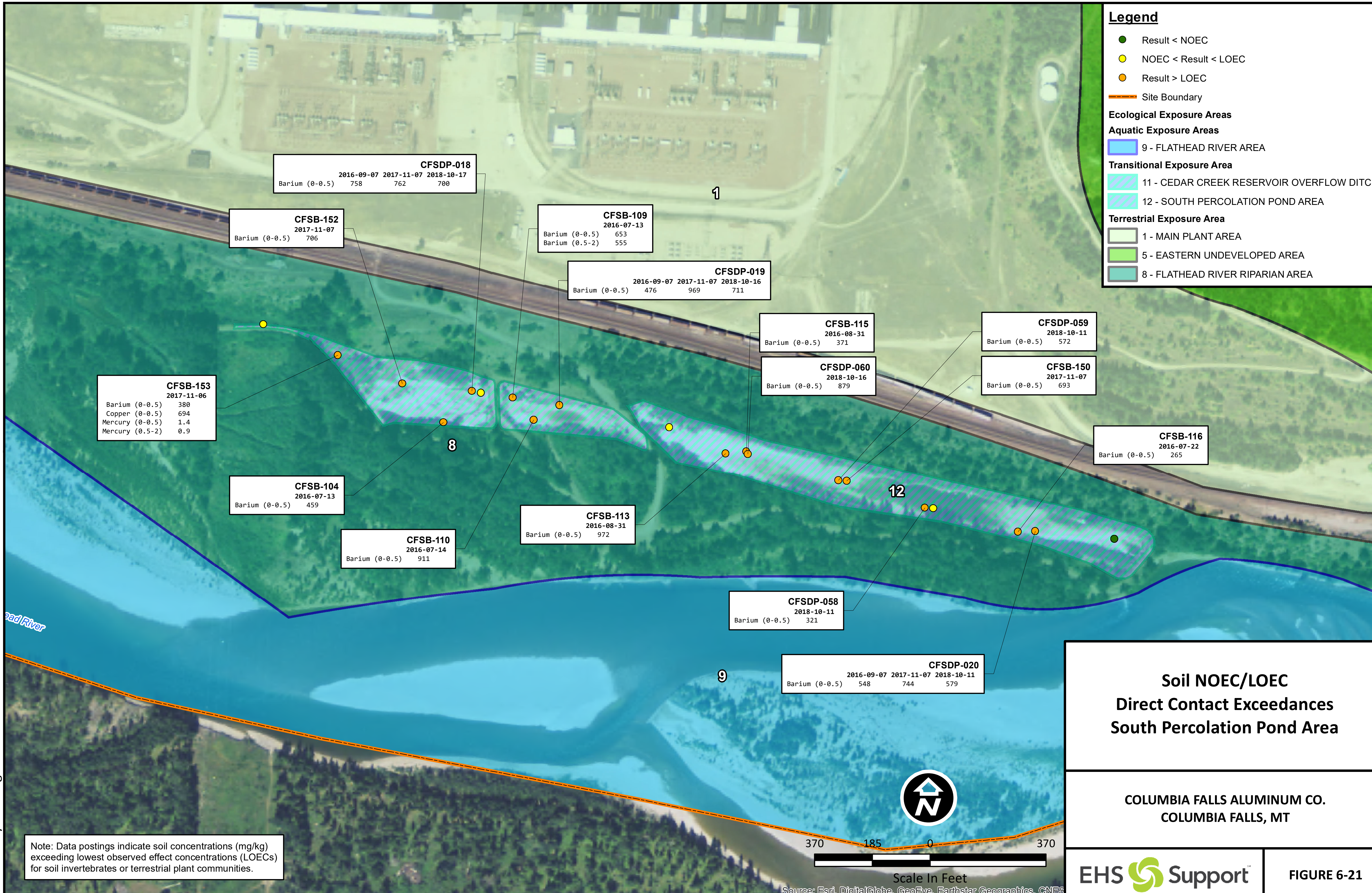

Soil NOEC/LOEC
Direct Contact Exceedances
South Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-21

Reviewed By: G. Long

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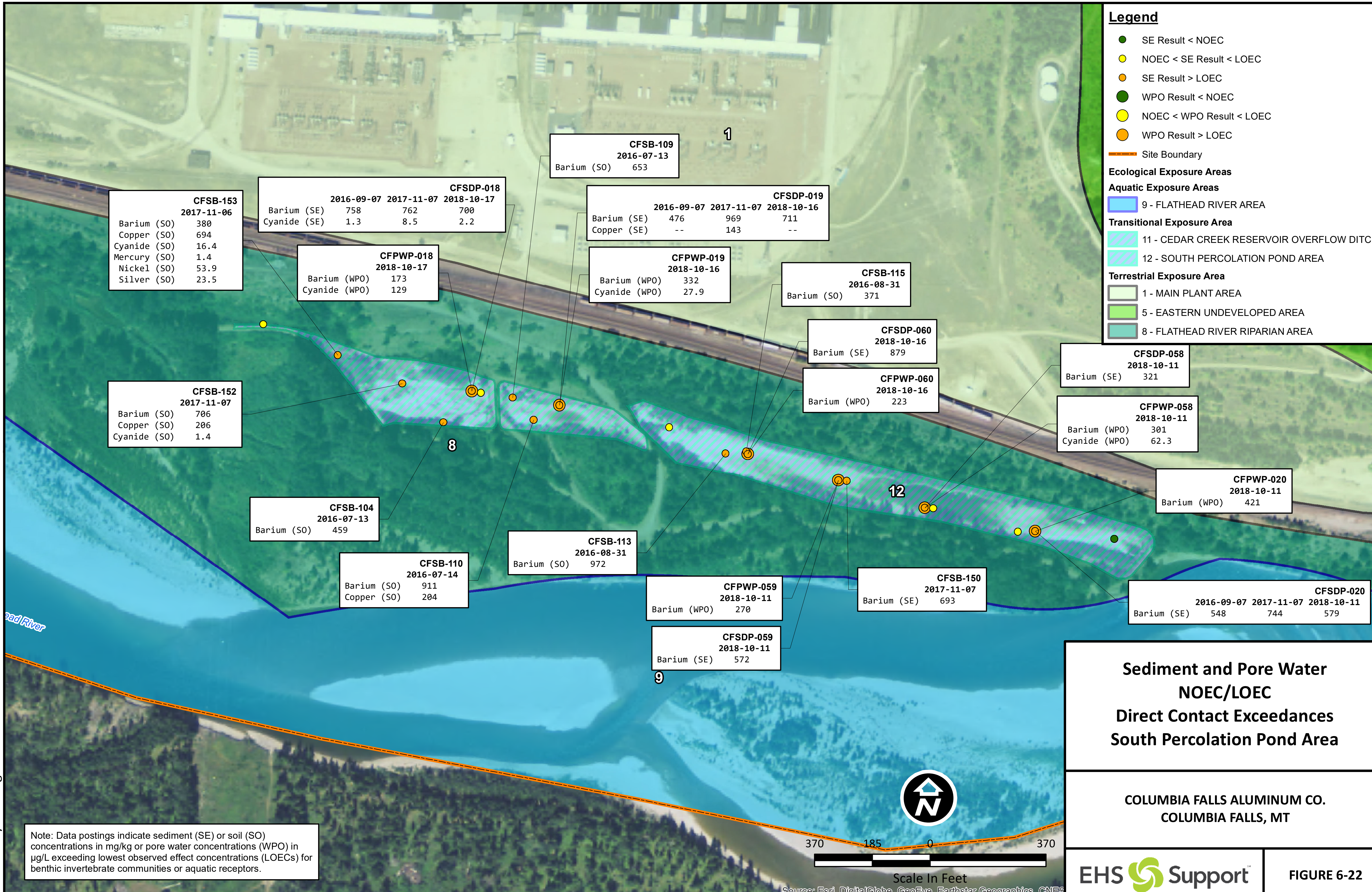

Note: Data postings indicate sediment (SE) or soil (SO) concentrations in mg/kg or pore water concentrations (WPO) in µg/L exceeding lowest observed effect concentrations (LOECs) for benthic invertebrate communities or aquatic receptors.

Sediment and Pore Water NOEC/LOEC Direct Contact Exceedances South Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-22

Reviewed By: G. Long

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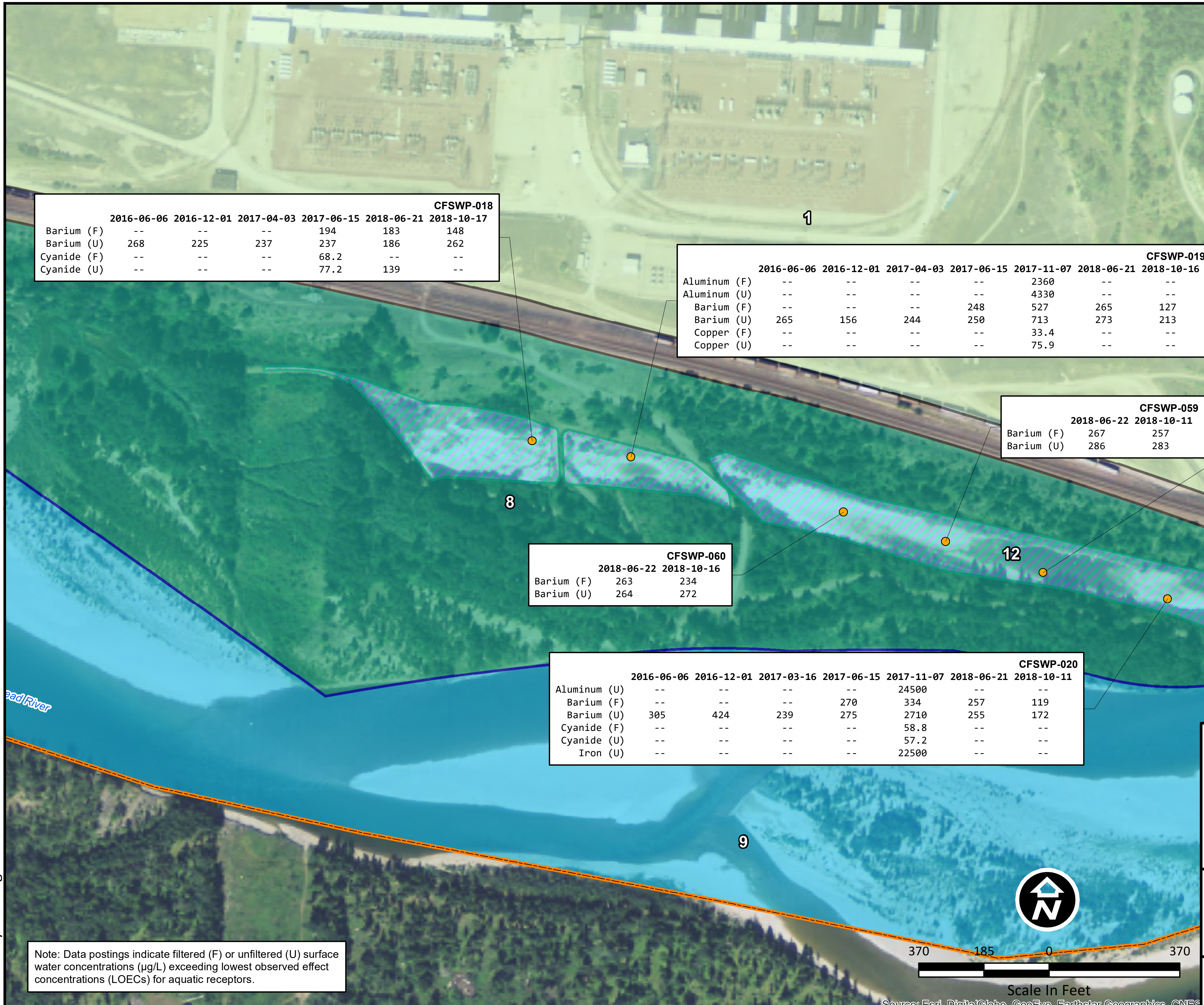

CFSWP-018

	2016-06-06	2016-12-01	2017-04-03	2017-06-15	2018-06-21	2018-10-17
Barium (F)	--	--	--	194	183	148
Barium (U)	268	225	237	237	186	262
Cyanide (F)	--	--	--	68.2	--	--
Cyanide (U)	--	--	--	77.2	139	--

CFSWP-019

	2016-06-06	2016-12-01	2017-04-03	2017-06-15	2017-11-07	2018-06-21	2018-10-16
Aluminum (F)	--	--	--	--	2360	--	--
Aluminum (U)	--	--	--	--	4330	--	--
Barium (F)	--	--	--	248	527	265	127
Barium (U)	265	156	244	250	713	273	213
Copper (F)	--	--	--	--	33.4	--	--
Copper (U)	--	--	--	--	75.9	--	--

CFSWP-059

	2018-06-22	2018-10-11
Barium (F)	267	257
Barium (U)	286	283

CFSWP-058

	2018-06-21	2018-10-11
Aluminum (F)	--	752
Barium (F)	261	452
Barium (U)	263	358
Cyanide (U)	--	30.8

CFSWP-060

	2018-06-22	2018-10-16
Barium (F)	263	234
Barium (U)	264	272

CFSWP-020

	2016-06-06	2016-12-01	2017-03-16	2017-06-15	2017-11-07	2018-06-21	2018-10-11
Aluminum (U)	--	--	--	--	24500	--	--
Barium (F)	--	--	--	270	334	257	119
Barium (U)	305	424	239	275	2710	255	172
Cyanide (F)	--	--	--	--	58.8	--	--
Cyanide (U)	--	--	--	--	57.2	--	--
Iron (U)	--	--	--	--	22500	--	--

Note: Data postings indicate filtered (F) or unfiltered (U) surface water concentrations (µg/L) exceeding lowest observed effect concentrations (LOECs) for aquatic receptors.

Surface Water NOEC/LOEC Direct Contact Exceedances South Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-23

Reviewed By: G. Long

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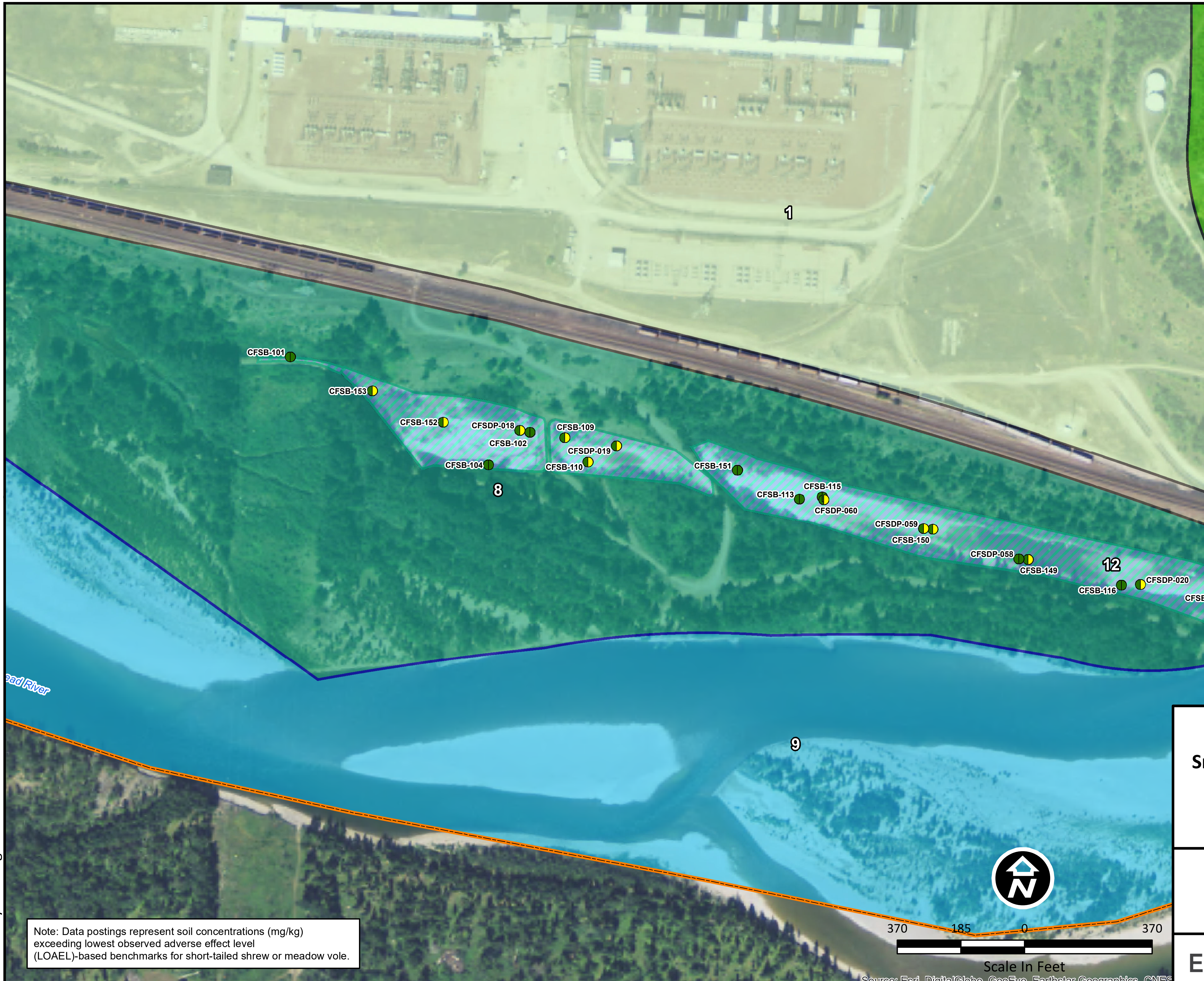

Note: Data postings represent soil concentrations (mg/kg) exceeding lowest observed adverse effect level (LOAEL)-based benchmarks for short-tailed shrew or meadow vole.

Legend

- Short-Tailed Shrew
- Meadow Vole
- Result <= BTV
- BTV < Result < = NOAEL
- NOAEL < Result <= LOAEL
- Result > LOAEL
- Site Boundary

Ecological Exposure Areas

Aquatic Exposure Areas

- 9 - FLATHEAD RIVER AREA

Transitional Exposure Area

- 11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
- 12 - SOUTH PERCOLATION POND AREA

Terrestrial Exposure Area

- 1 - MAIN PLANT AREA
- 5 - EASTERN UNDEVELOPED AREA
- 8 - FLATHEAD RIVER RIPARIAN AREA

Small Range Receptors Exceedances South Percolation Pond Area

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-24

Reviewed By: G. Long

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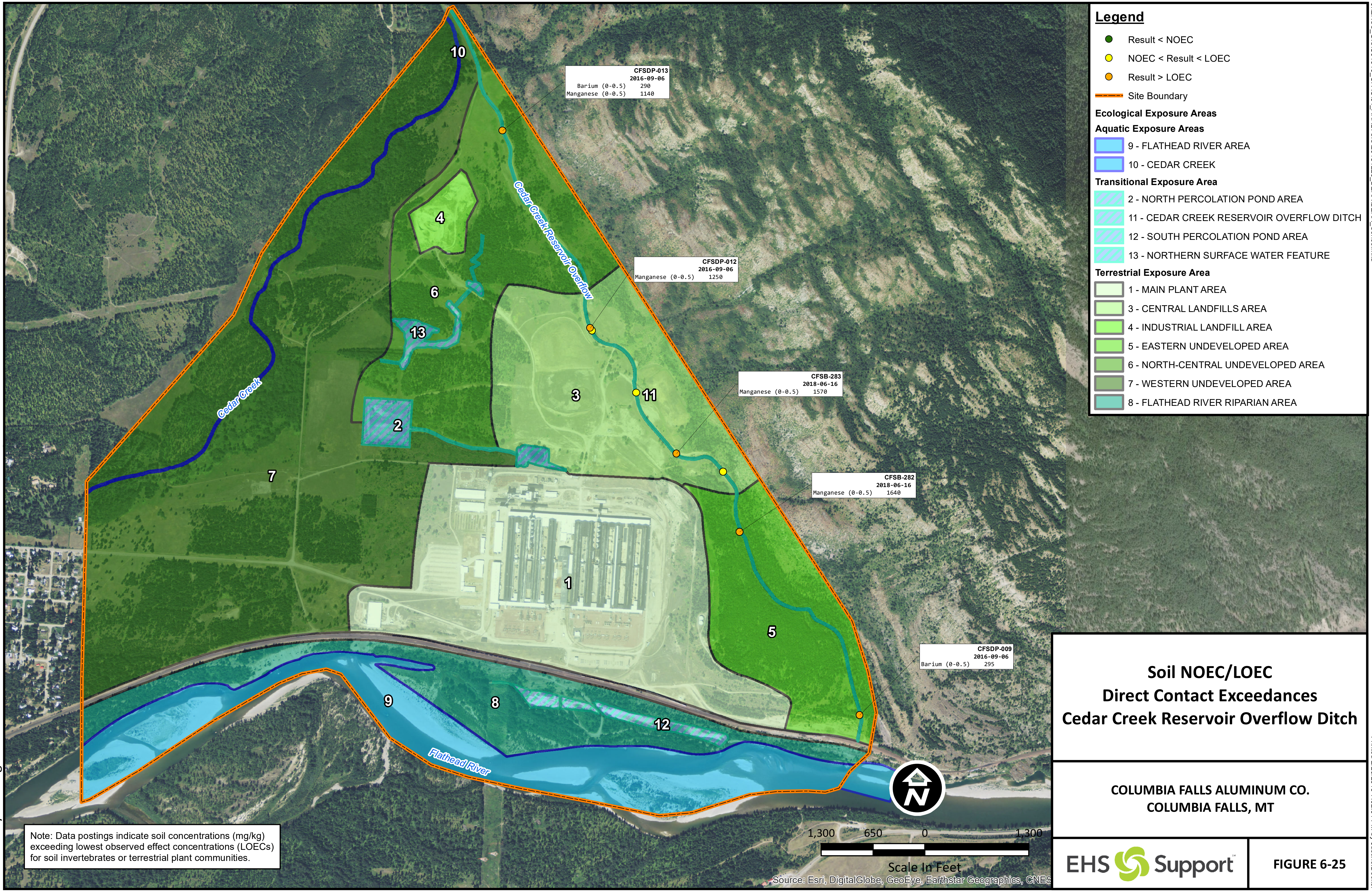
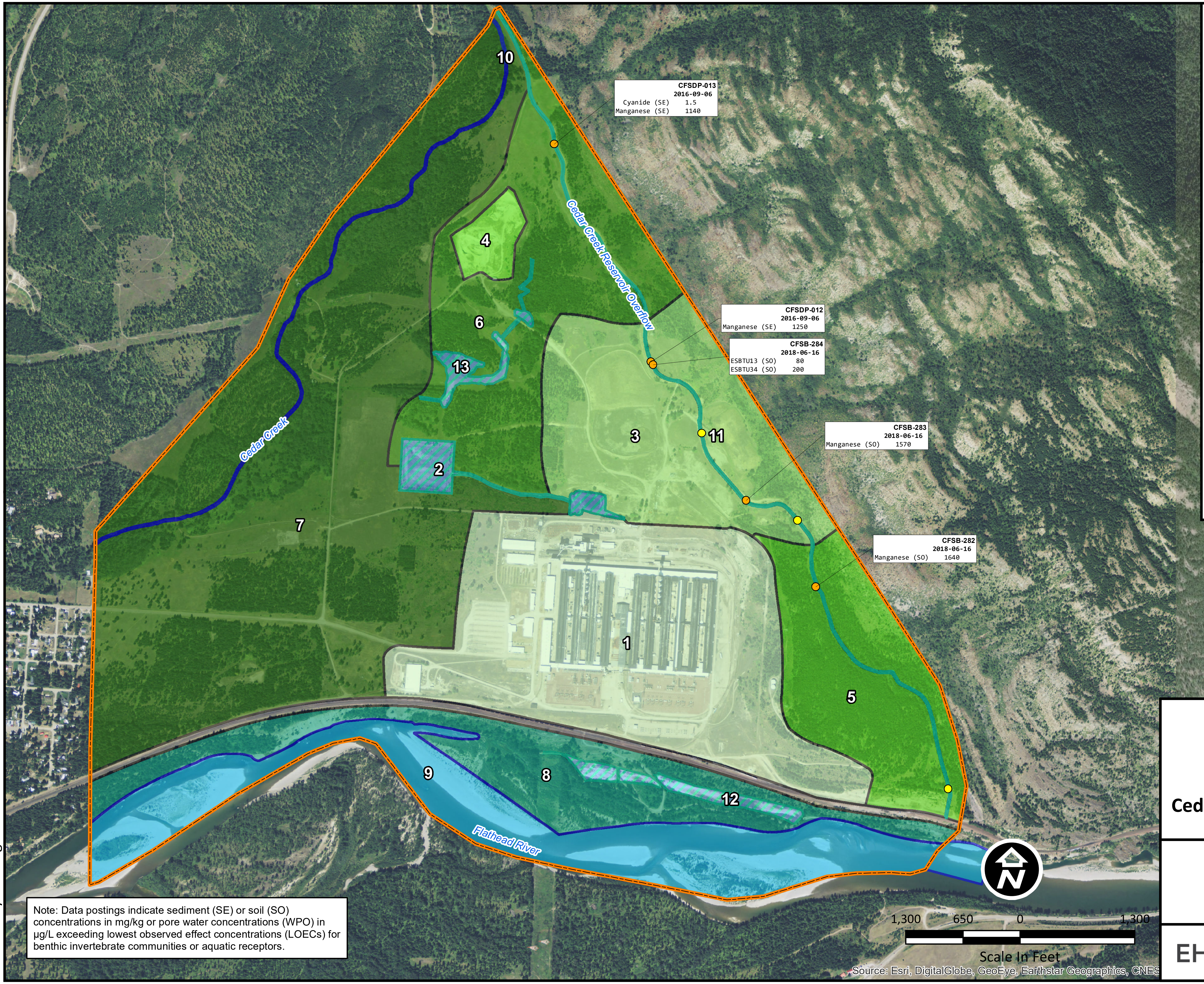


Soil NOEC/LOEC Direct Contact Exceedances Cedar Creek Reservoir Overflow Ditch

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-25



Reviewed By: G. Long

Note: Data postings indicate sediment (SE) or soil (SO) concentrations in mg/kg or pore water concentrations (WPO) in µg/L exceeding lowest observed effect concentrations (LOECs) for benthic invertebrate communities or aquatic receptors.

Legend

- SE Result < NOEC
- NOEC < SE Result < LOEC
- SE Result > LOEC
- WPO Result < NOEC
- NOEC < WPO Result < LOEC
- WPO Result > LOEC
- Site Boundary

Ecological Exposure Areas

Aquatic Exposure Areas

- 9 - FLATHEAD RIVER AREA
- 10 - CEDAR CREEK

Transitional Exposure Area

- 2 - NORTH PERCOLATION POND AREA
- 11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
- 12 - SOUTH PERCOLATION POND AREA
- 13 - NORTHERN SURFACE WATER FEATURE

Terrestrial Exposure Area

- 1 - MAIN PLANT AREA
- 3 - CENTRAL LANDFILLS AREA
- 4 - INDUSTRIAL LANDFILL AREA
- 5 - EASTERN UNDEVELOPED AREA
- 6 - NORTH-CENTRAL UNDEVELOPED AREA
- 7 - WESTERN UNDEVELOPED AREA
- 8 - FLATHEAD RIVER RIPARIAN AREA

Sediment and Pore Water NOEC/LOEC Direct Contact Exceedances Cedar Creek Reservoir Overflow Ditch

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-26

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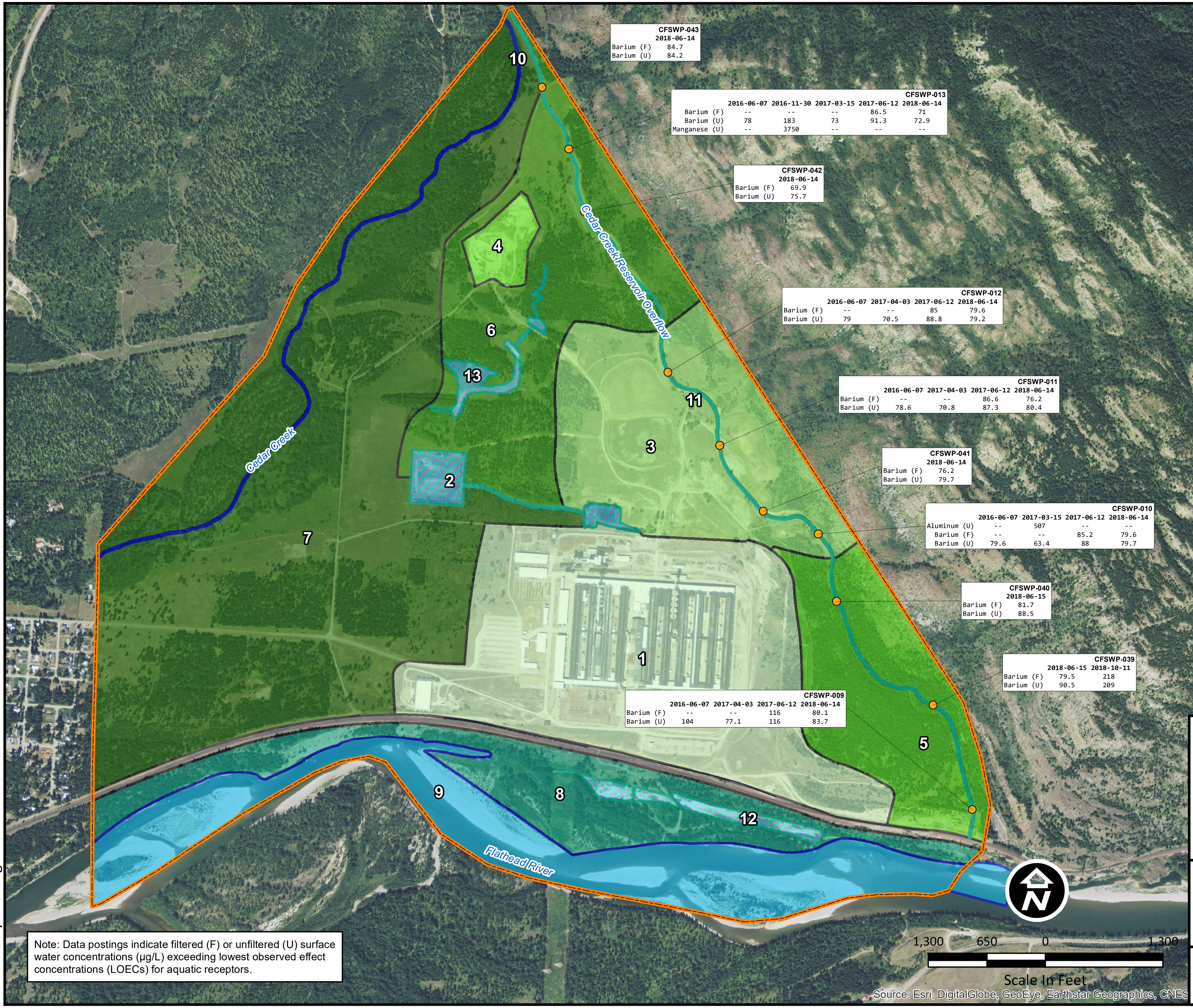

Note: Data postings indicate filtered (F) or unfiltered (U) surface water concentrations (µg/L) exceeding lowest observed effect concentrations (LOECs) for aquatic receptors.

Legend

- Result < NOEC
- NOEC < Result < LOEC
- Result > LOEC
- Site Boundary

Ecological Exposure Areas

Aquatic Exposure Areas

- 9 - FLATHEAD RIVER AREA
- 10 - CEDAR CREEK

Transitional Exposure Area

- 2 - NORTH PERCOLATION POND AREA
- 11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
- 12 - SOUTH PERCOLATION POND AREA
- 13 - NORTHERN SURFACE WATER FEATURE

Terrestrial Exposure Area

- 1 - MAIN PLANT AREA
- 3 - CENTRAL LANDFILLS AREA
- 4 - INDUSTRIAL LANDFILL AREA
- 5 - EASTERN UNDEVELOPED AREA
- 6 - NORTH-CENTRAL UNDEVELOPED AREA
- 7 - WESTERN UNDEVELOPED AREA
- 8 - FLATHEAD RIVER RIPARIAN AREA

Surface Water NOEC/LOEC Direct Contact Exceedances Cedar Creek Reservoir Overflow Ditch

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-27

Reviewed By: G. Long

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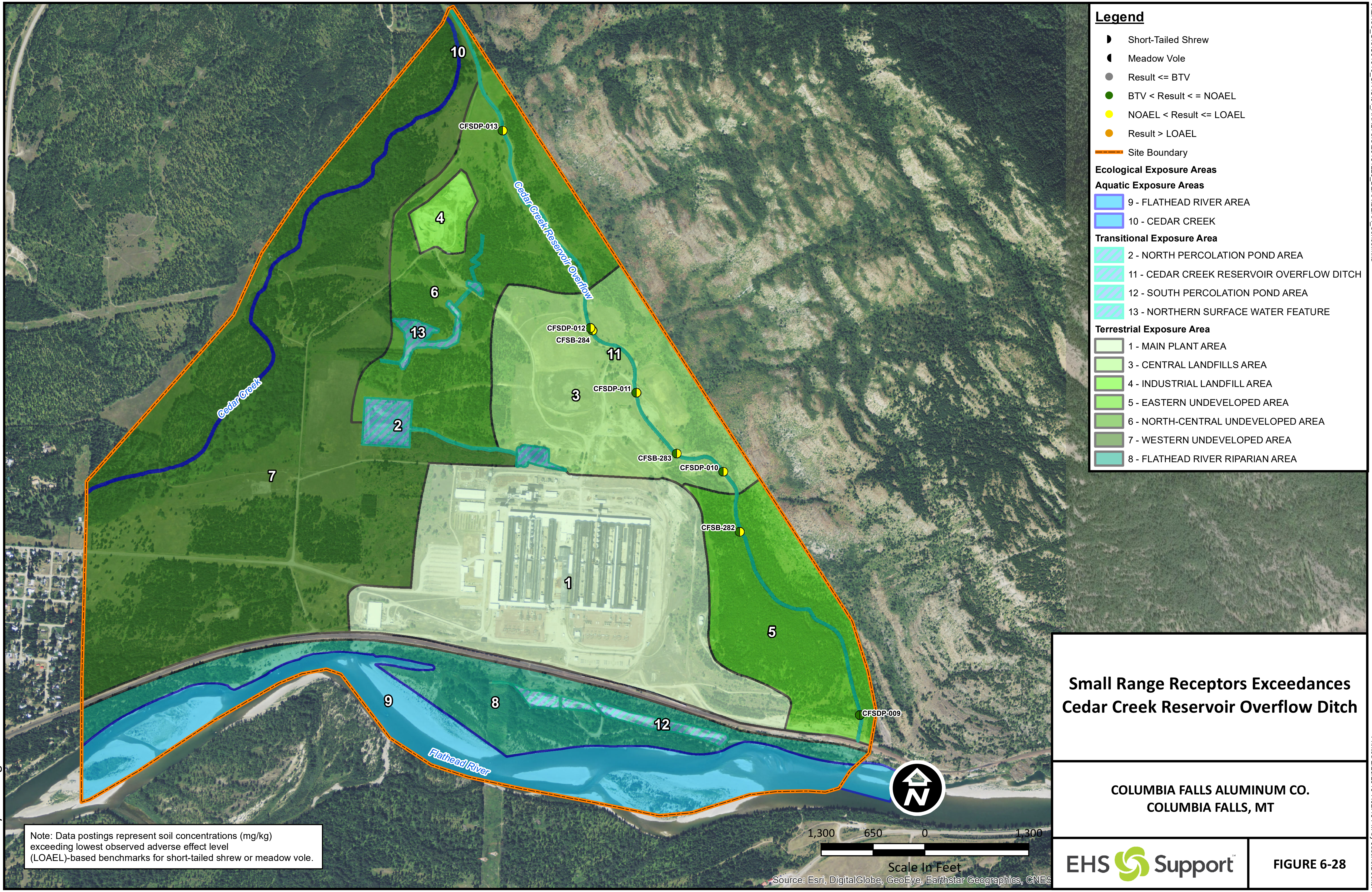

Note: Data postings represent soil concentrations (mg/kg) exceeding lowest observed adverse effect level (LOAEL)-based benchmarks for short-tailed shrew or meadow vole.

Reviewed By: G. Long

Small Range Receptors Exceedances Cedar Creek Reservoir Overflow Ditch

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-28

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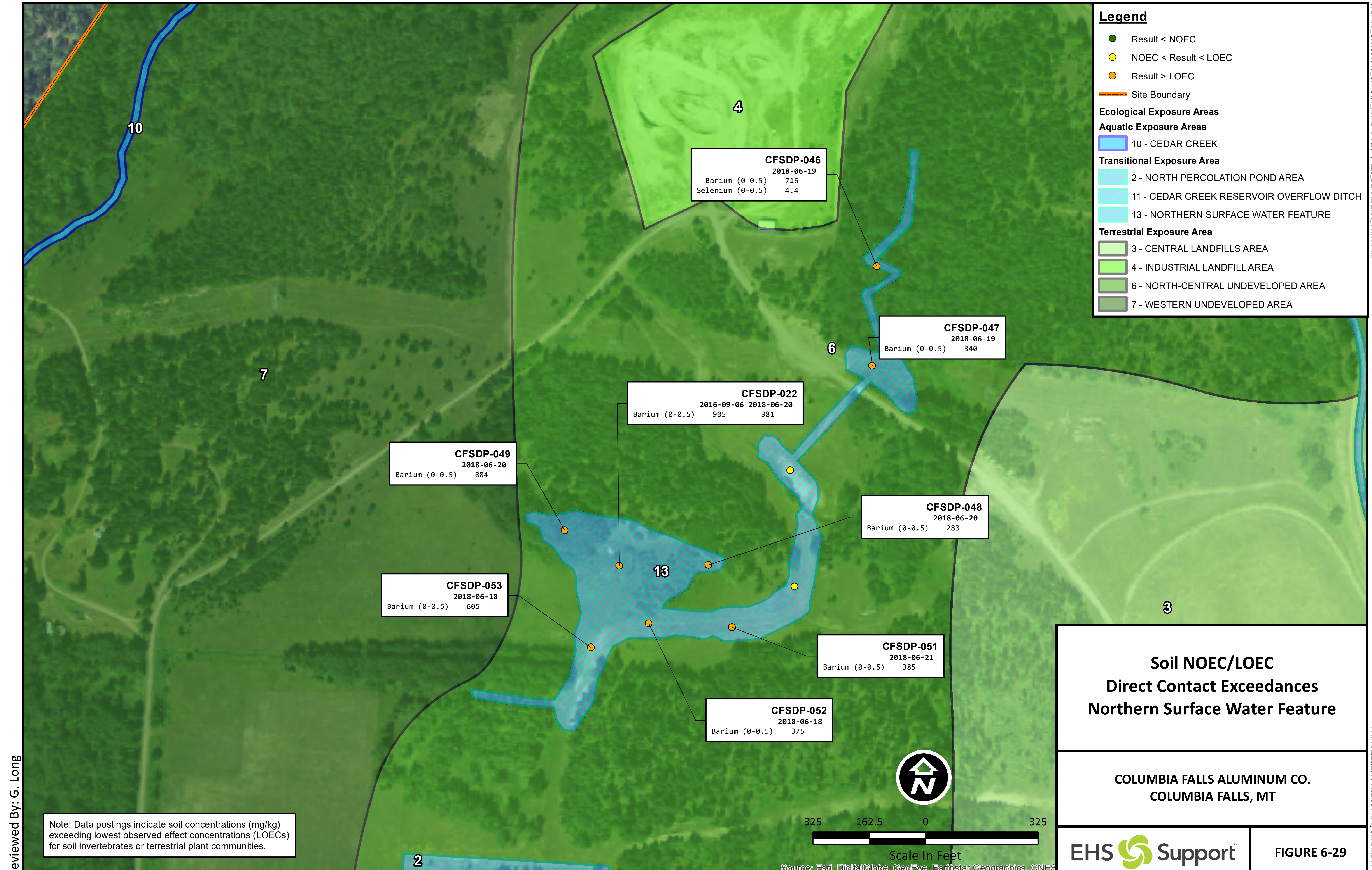

Legend
Result < NOEC
NOEC < Result < LOEC
Result > LOEC
Site Boundary
Ecological Exposure Areas
Aquatic Exposure Areas
10 - CEDAR CREEK
Transitional Exposure Area
2 - NORTH PERCOLATION POND AREA
11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
13 - NORTHERN SURFACE WATER FEATURE
Terrestrial Exposure Area
3 - CENTRAL LANDFILLS AREA
4 - INDUSTRIAL LANDFILL AREA
6 - NORTH-CENTRAL UNDEVELOPED AREA
7 - WESTERN UNDEVELOPED AREA
10
4
7
6
13
3
2
CFSDP-046 2018-06-19 Barium (0-0.5) 716 Selenium (0-0.5) 4.4
CFSDP-047 2018-06-19 Barium (0-0.5) 340
CFSDP-022 2016-09-06 2018-06-20 Barium (0-0.5) 905 381
CFSDP-049 2018-06-20 Barium (0-0.5) 884
CFSDP-048 2018-06-20 Barium (0-0.5) 283
CFSDP-053 2018-06-18 Barium (0-0.5) 605
CFSDP-051 2018-06-21 Barium (0-0.5) 385
CFSDP-052 2018-06-18 Barium (0-0.5) 375
Note: Data postings indicate soil concentrations (mg/kg) exceeding lowest observed effect concentrations (LOECs) for soil invertebrates or terrestrial plant communities.
N
325 162.5 0 325
Scale In Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES
Soil NOEC/LOEC
Direct Contact Exceedances
Northern Surface Water Feature
COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT
EHS Support
FIGURE 6-29
Reviewed By: G. Long
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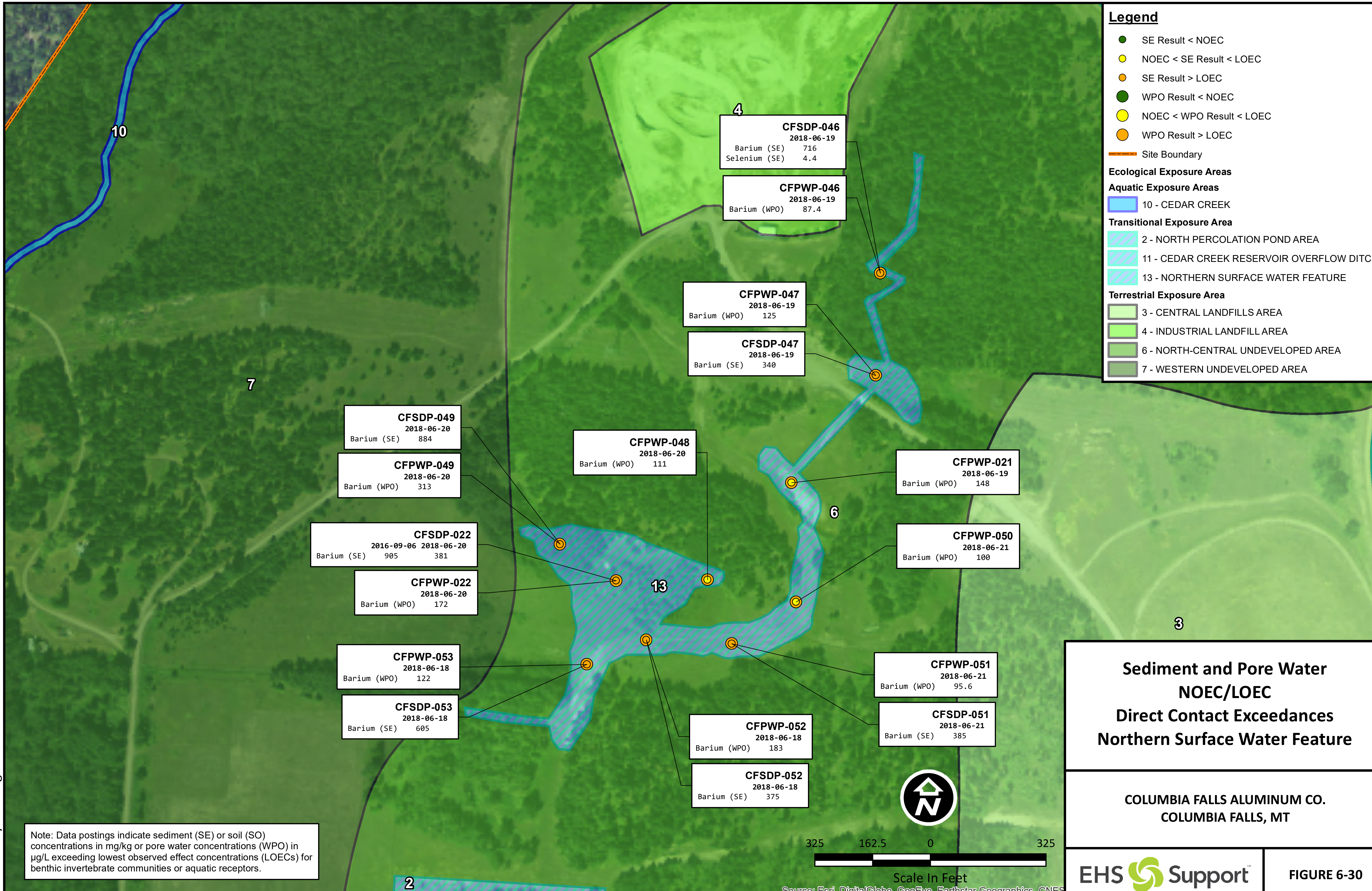

Note: Data postings indicate sediment (SE) or soil (SO) concentrations in mg/kg or pore water concentrations (WPO) in µg/L exceeding lowest observed effect concentrations (LOECs) for benthic invertebrate communities or aquatic receptors.

Sediment and Pore Water NOEC/LOEC Direct Contact Exceedances Northern Surface Water Feature

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-30

Reviewed By: G. Long

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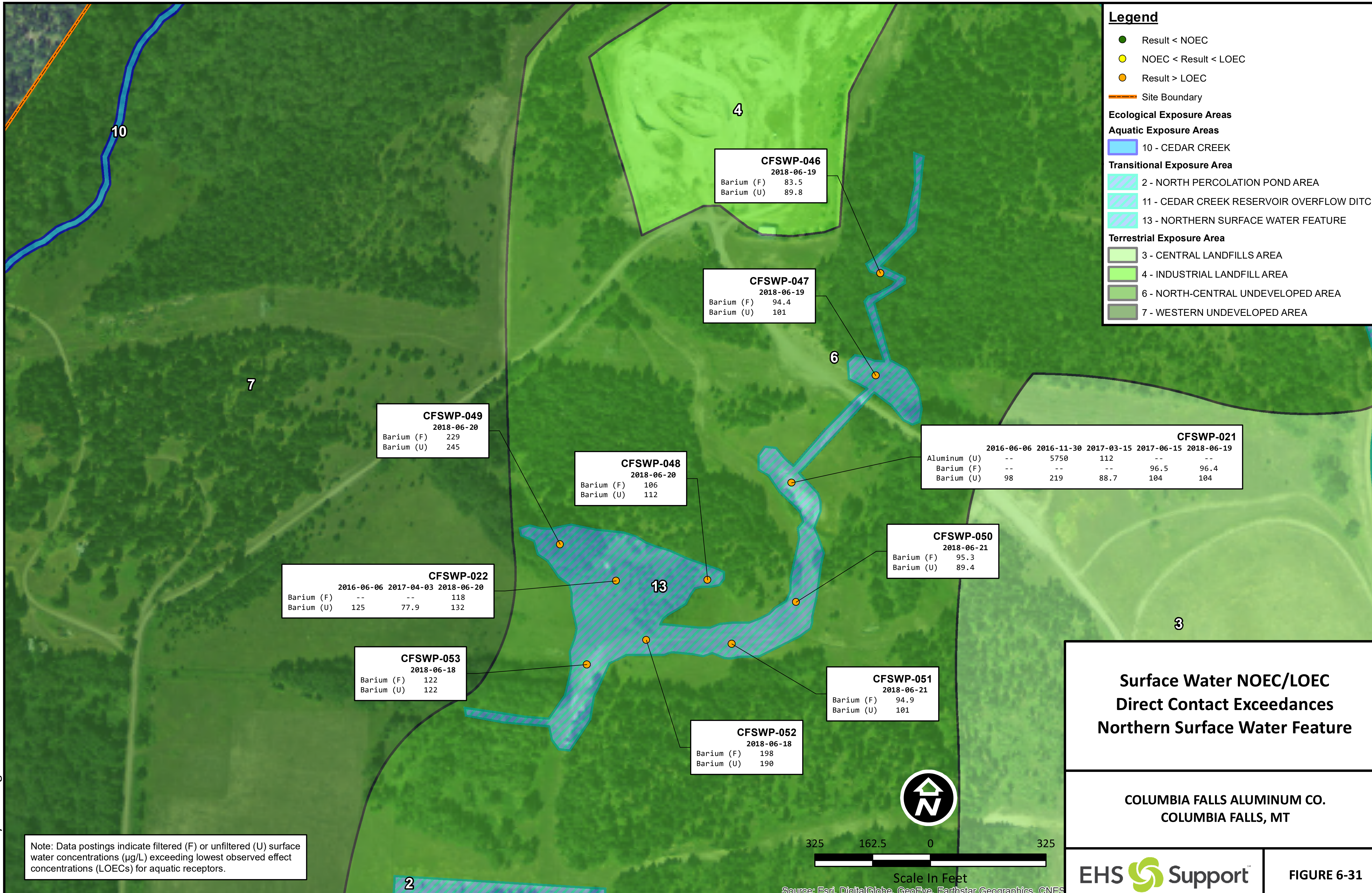
Legend
Result < NOEC
NOEC < Result < LOEC
Result > LOEC
Site Boundary
Ecological Exposure Areas
Aquatic Exposure Areas
10 - CEDAR CREEK
Transitional Exposure Area
2 - NORTH PERCOLATION POND AREA
11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
13 - NORTHERN SURFACE WATER FEATURE
Terrestrial Exposure Area
3 - CENTRAL LANDFILLS AREA
4 - INDUSTRIAL LANDFILL AREA
6 - NORTH-CENTRAL UNDEVELOPED AREA
7 - WESTERN UNDEVELOPED AREA
10
4
7
6
13
3
2
CFSWP-046 2018-06-19 Barium (F) 83.5 Barium (U) 89.8
CFSWP-047 2018-06-19 Barium (F) 94.4 Barium (U) 101
CFSWP-049 2018-06-20 Barium (F) 229 Barium (U) 245
CFSWP-048 2018-06-20 Barium (F) 106 Barium (U) 112
CFSWP-021 2016-06-06 2016-11-30 2017-03-15 2017-06-15 2018-06-19
Aluminum (U) -- 5750 112 -- --
Barium (F) -- -- -- 96.5 96.4
Barium (U) 98 219 88.7 104 104
CFSWP-050 2018-06-21 Barium (F) 95.3 Barium (U) 89.4
CFSWP-022 2016-06-06 2017-04-03 2018-06-20
Barium (F) -- -- 118
Barium (U) 125 77.9 132
CFSWP-053 2018-06-18 Barium (F) 122 Barium (U) 122
CFSWP-051 2018-06-21 Barium (F) 94.9 Barium (U) 101
CFSWP-052 2018-06-18 Barium (F) 198 Barium (U) 190
Note: Data postings indicate filtered (F) or unfiltered (U) surface water concentrations (µg/L) exceeding lowest observed effect concentrations (LOECs) for aquatic receptors.
N
325 162.5 0 325
Scale In Feet
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES
Surface Water NOEC/LOEC Direct Contact Exceedances Northern Surface Water Feature
COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT
EHS Support
FIGURE 6-31
Reviewed By: G. Long
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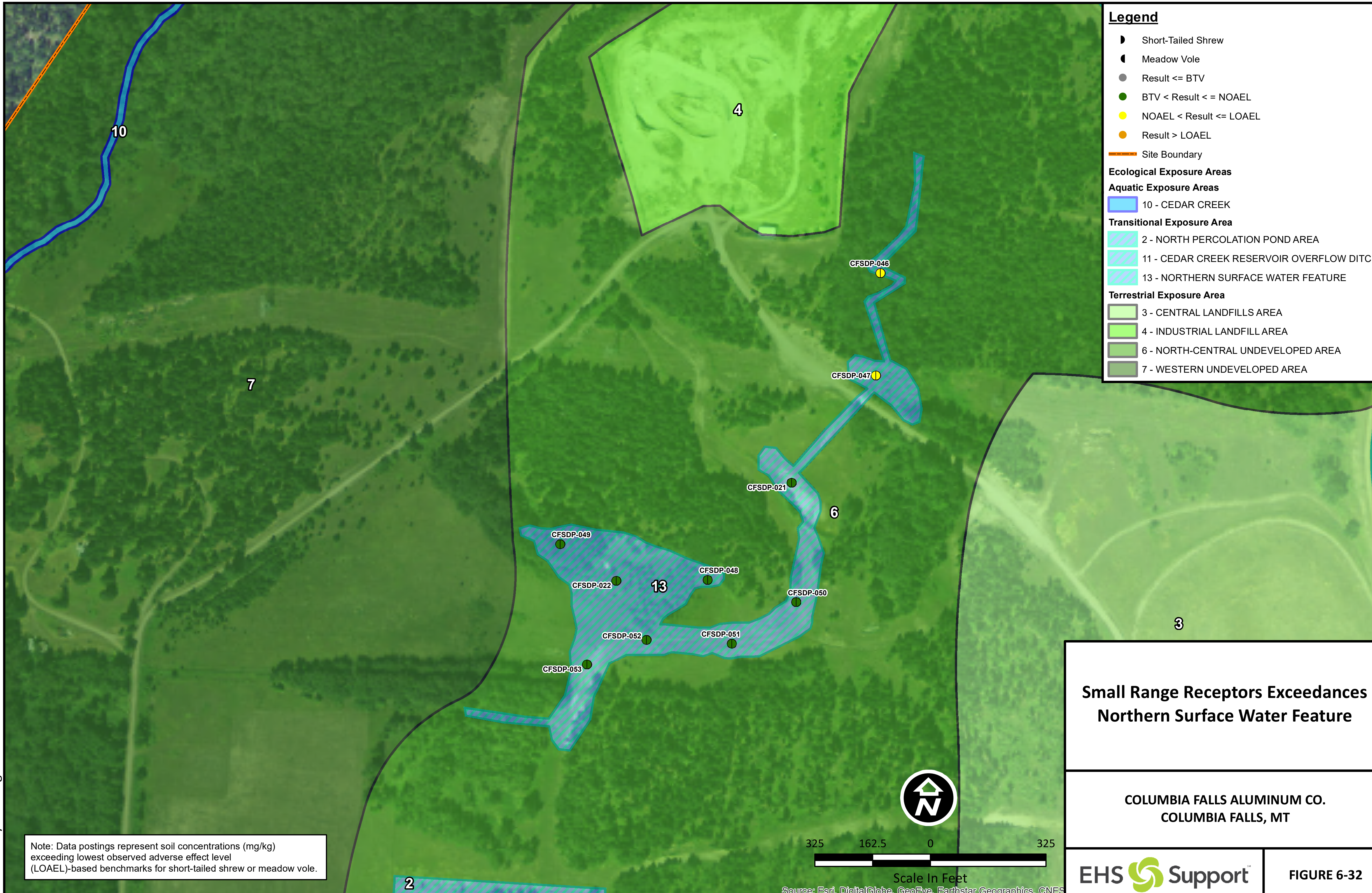

Small Range Receptors Exceedances
Northern Surface Water Feature

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-32

Reviewed By: G. Long

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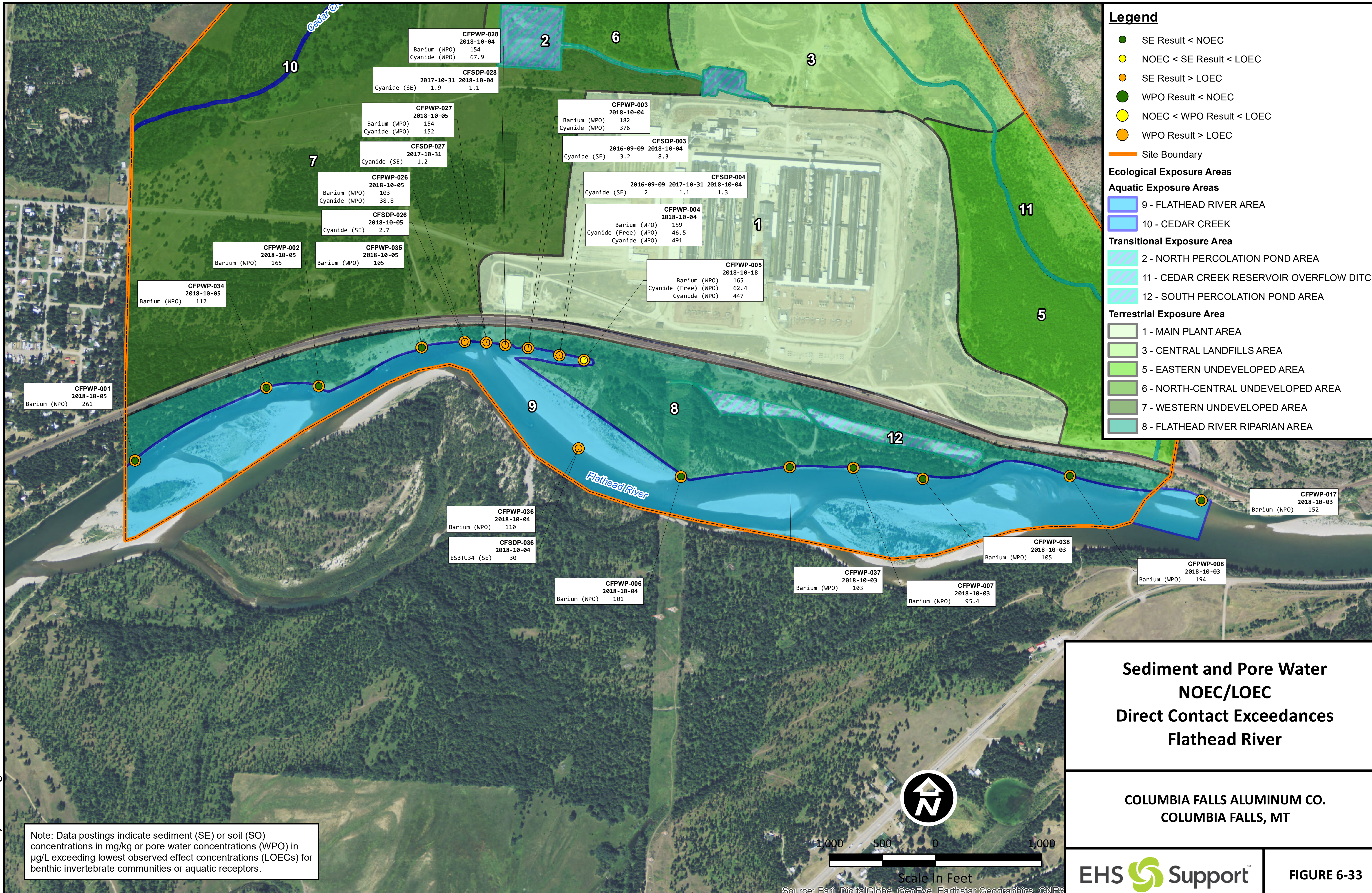

Note: Data postings indicate sediment (SE) or soil (SO) concentrations in mg/kg or pore water concentrations (WPO) in µg/L exceeding lowest observed effect concentrations (LOECs) for benthic invertebrate communities or aquatic receptors.

Sediment and Pore Water NOEC/LOEC Direct Contact Exceedances Flathead River

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-33

Reviewed By: G. Long

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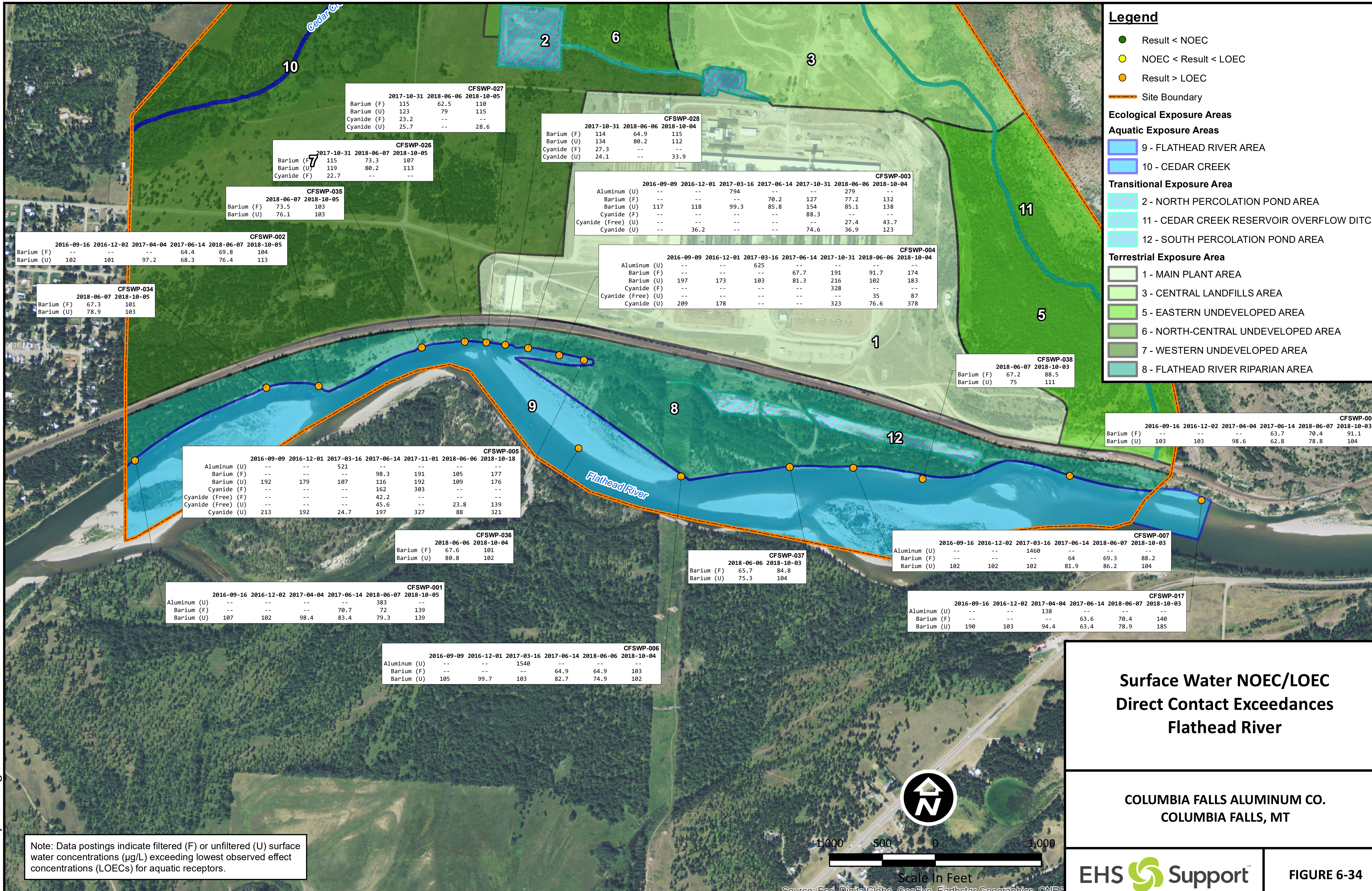

Note: Data postings indicate filtered (F) or unfiltered (U) surface water concentrations (µg/L) exceeding lowest observed effect concentrations (LOECs) for aquatic receptors.

Surface Water NOEC/LOEC Direct Contact Exceedances Flathead River

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-34

Reviewed By: G. Long

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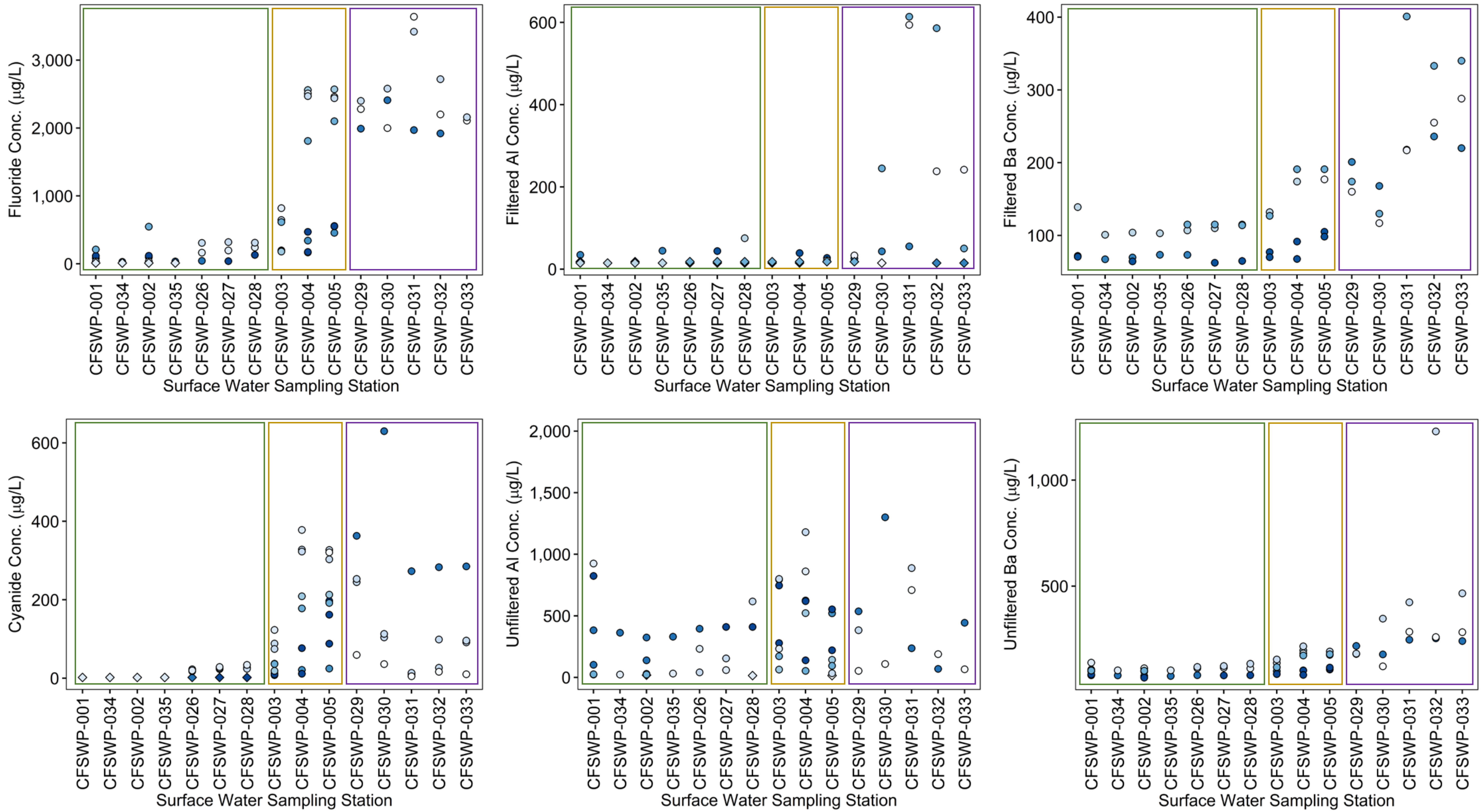


Legend

Discharge Percentile

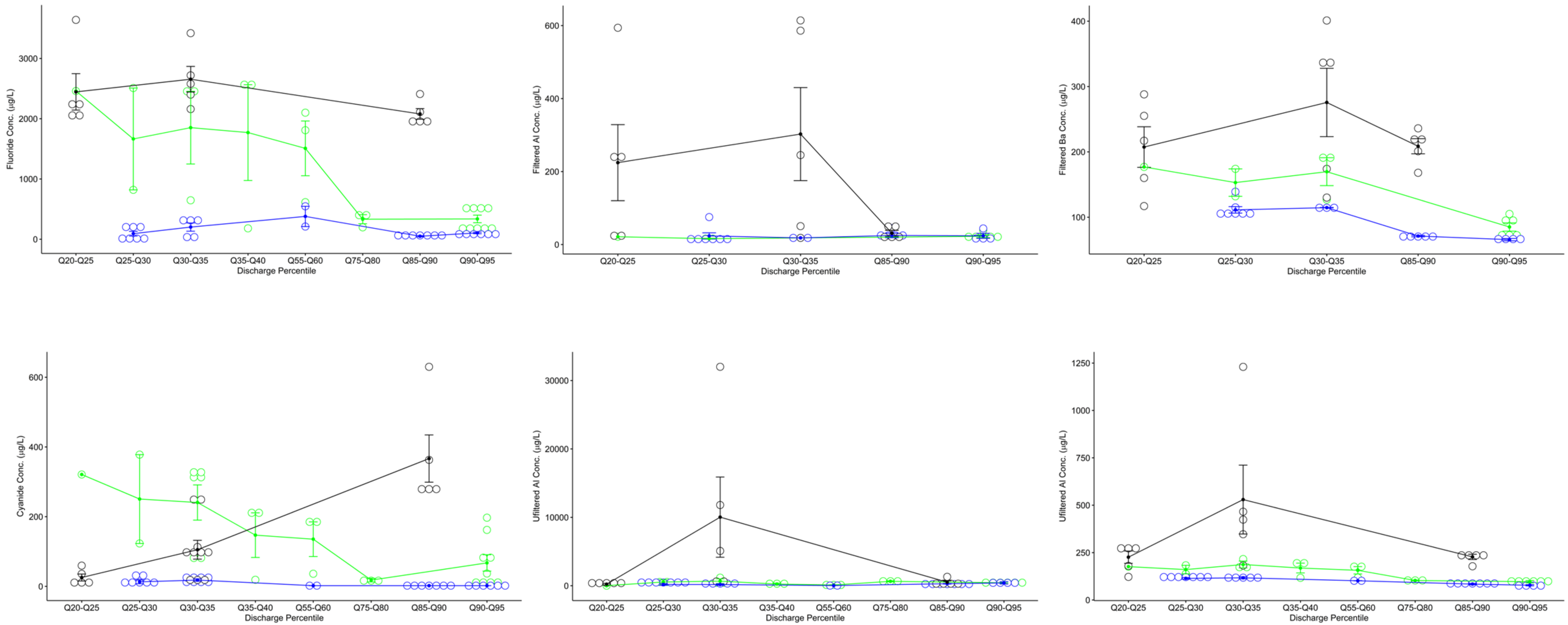
- Q20-Q25 (3,060-3,520 cfs)
- Q25-Q30 (3,520-3,710 cfs)
- Q30-Q35 (3,710-3,870 cfs)
- Q35-Q40 (3,870-4,200 cfs)
- Q55-Q60 (6,720-7,790 cfs)
- Q75-Q80 (11,500-14,000 cfs)
- Q85-Q90 (18,000-23,300 cfs)
- Q90-Q95 (23,300-31,800 cfs)

- Downstream Portion of Flathead River
- Backwater Seep Area of Flathead River
- Riparian Area of Flathead River

Notes

- Three outliers are not pictured in unfiltered aluminum plot: CFSWP-030 = 11,800 µg/L; CFSWP-032 = 32,000 µg/L; and, CFSWP-033 = 5,090 µg/L;

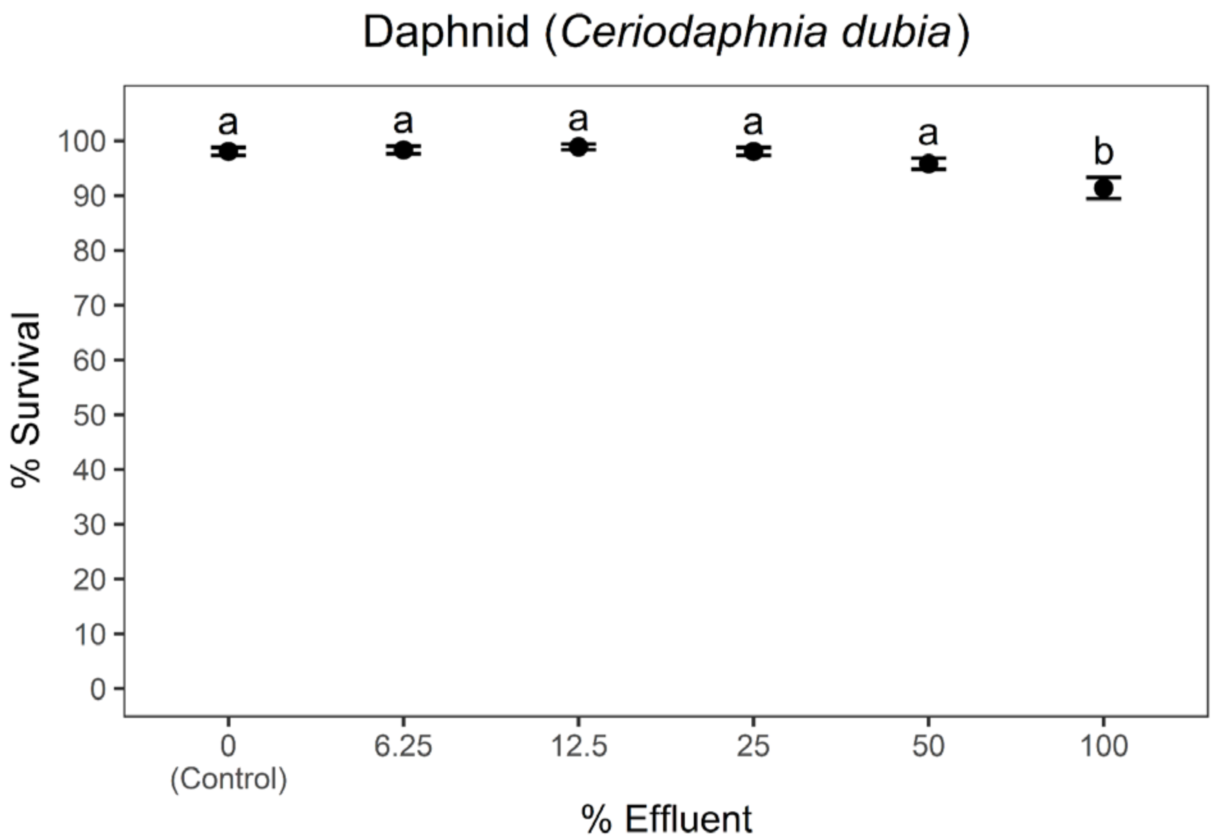
FIGURE 6-35	EHS Support
FLUORIDE, CYANIDE, ALUMINUM, AND BARIUM SURFACE WATER CONCENTRATION BY STATION AND DISCHARGE PERCENTILE	
Prepared by: S. Parker	Checked by: S. Parker
Project: CFAC - BERA	Date: February 6, 2019

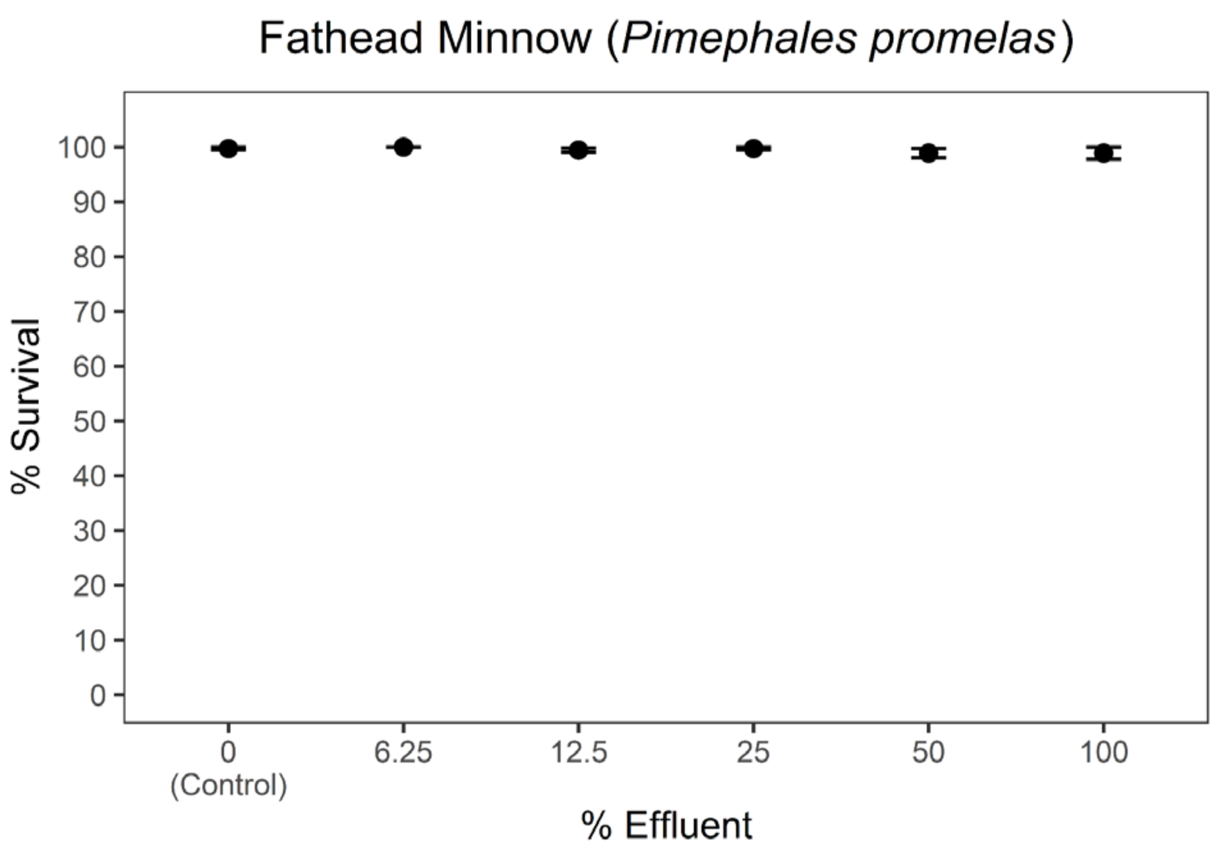


Legend

- Backwater Seep Flathead River
- Riparian Area Flathead River
- Downgradient Flathead River

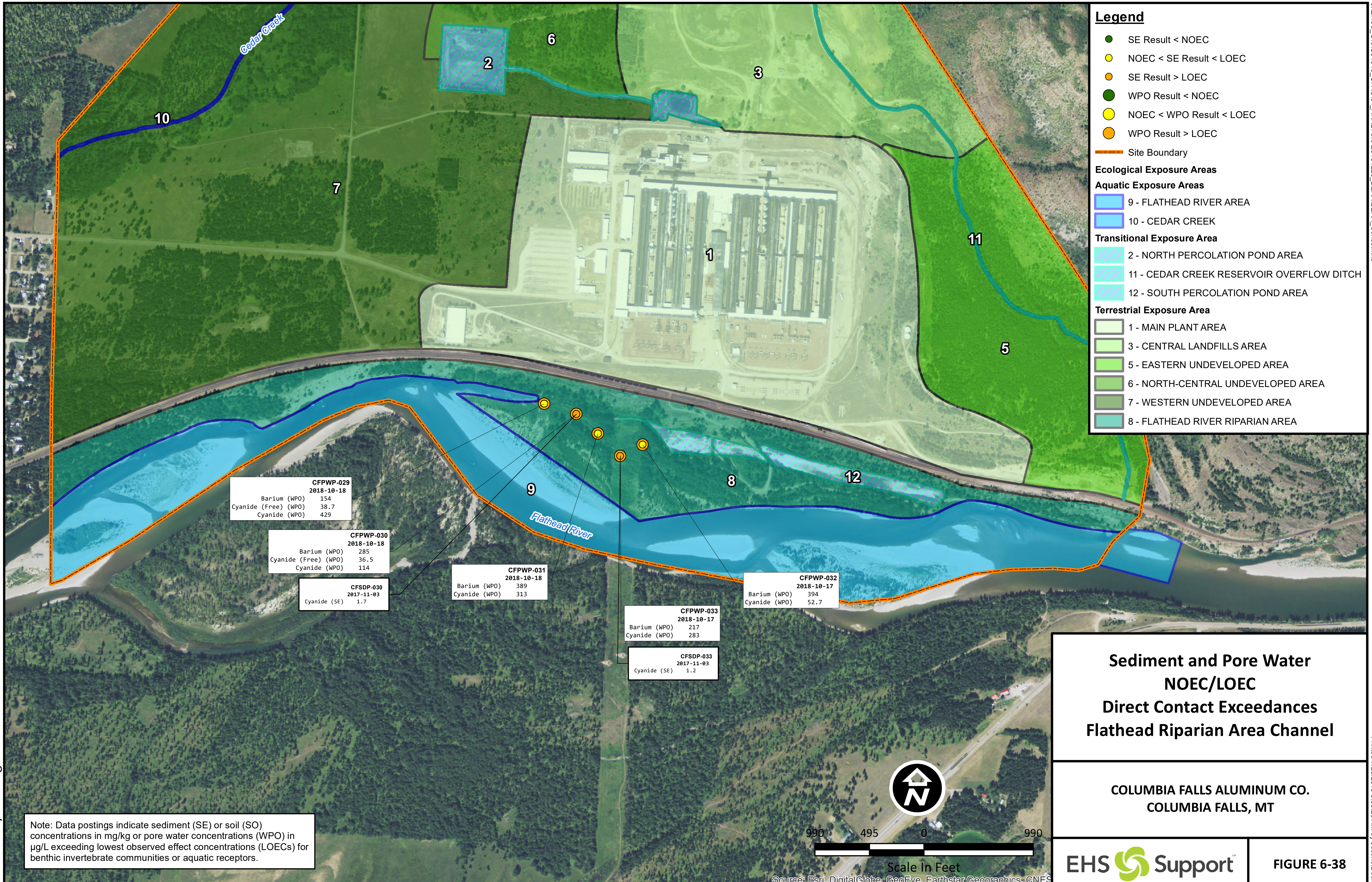
FIGURE 6-36	EHS Support
FLUORIDE, CYANIDE, ALUMINUM, AND BARIUM SURFACE WATER CONCENTRATION BY AREA AND DISCHARGE PERCENTILE	
Prepared by: S. Parker	Checked by: S. Parker
Project: CFAC - BERA	Date: February 6, 2019





Note:
Different letters indicate statistically significant differences ($p<0.05$) in mean *Ceriodaphnia dubia* survival; there was no significant effect ($p>0.05$) of the percent effluent on the percent survival of Fathead Minnow

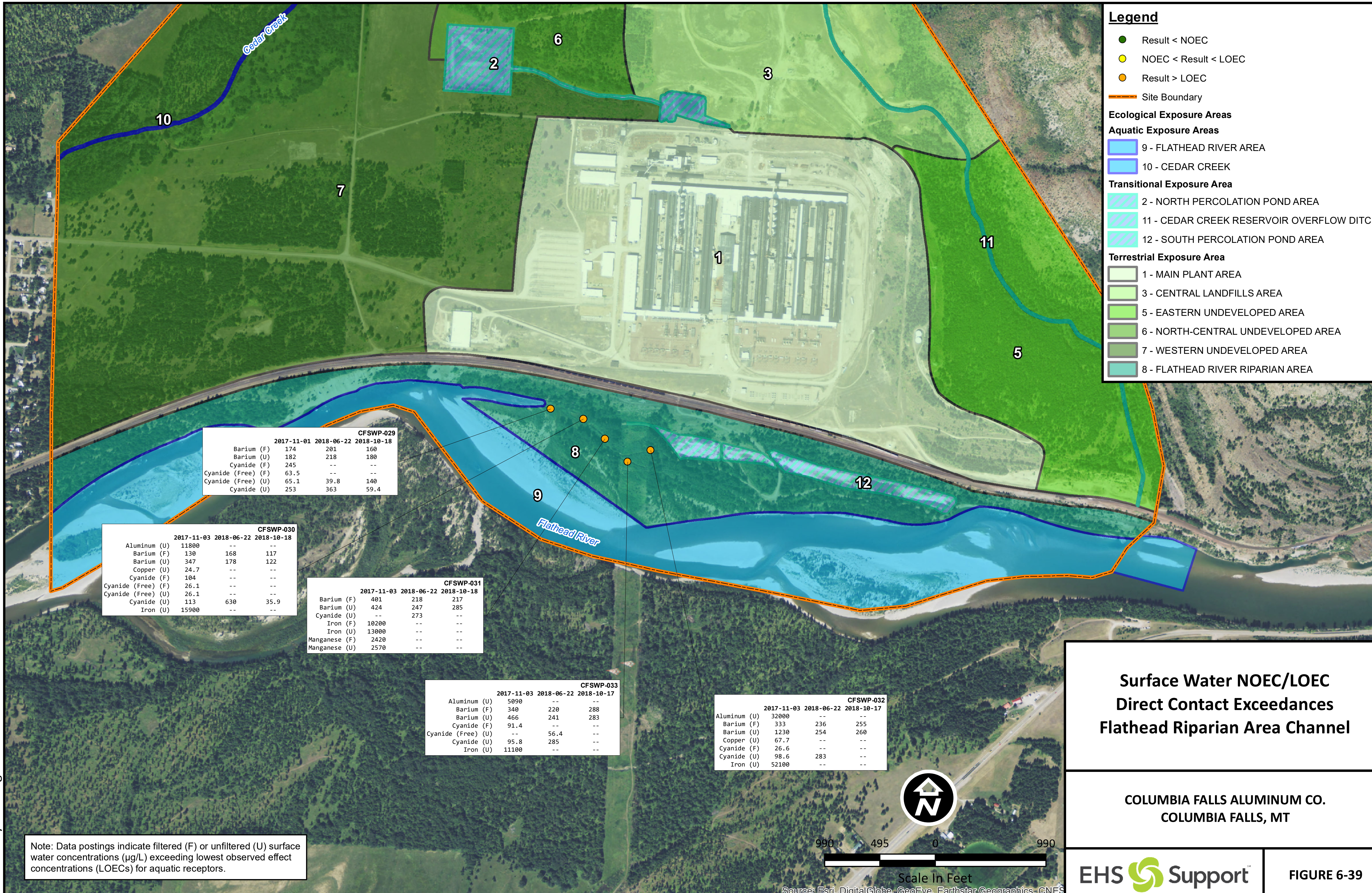
EHS Support	COLUMBIA FALLS ALUMINUM CO. COLUMBIA FALLS, MT	Mean Survival (± Standard Error) of *Ceriodaphnia dubia* and Fathead Minnow (*Pimephales promelas*) in Whole Effluent Toxicity (WET) Testing	FIGURE 6-37



Sediment and Pore Water NOEC/LOEC Direct Contact Exceedances Flathead Riparian Area Channel

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

FIGURE 6-38



CFSWP-029	2017-11-01	2018-06-22	2018-10-18
Barium (F)	174	201	160
Barium (U)	182	218	180
Cyanide (F)	245	--	--
Cyanide (Free) (F)	63.5	--	--
Cyanide (Free) (U)	65.1	39.8	140
Cyanide (U)	253	363	59.4

CFSWP-030	2017-11-03	2018-06-22	2018-10-18
Aluminum (U)	11800	--	--
Barium (F)	130	168	117
Barium (U)	347	178	122
Copper (U)	24.7	--	--
Cyanide (F)	104	--	--
Cyanide (Free) (F)	26.1	--	--
Cyanide (Free) (U)	26.1	--	--
Cyanide (U)	113	630	35.9
Iron (U)	15900	--	--

CFSWP-031	2017-11-03	2018-06-22	2018-10-18
Barium (F)	401	218	217
Barium (U)	424	247	285
Cyanide (U)	--	273	--
Iron (F)	10200	--	--
Iron (U)	13000	--	--
Manganese (F)	2420	--	--
Manganese (U)	2570	--	--

CFSWP-033	2017-11-03	2018-06-22	2018-10-17
Aluminum (U)	5090	--	--
Barium (F)	340	220	288
Barium (U)	466	241	283
Cyanide (F)	91.4	--	--
Cyanide (Free) (U)	--	56.4	--
Cyanide (U)	95.8	285	--
Iron (U)	11100	--	--

CFSWP-032	2017-11-03	2018-06-22	2018-10-17
Aluminum (U)	32000	--	--
Barium (F)	333	236	255
Barium (U)	1230	254	260
Copper (U)	67.7	--	--
Cyanide (F)	26.6	--	--
Cyanide (U)	98.6	283	--
Iron (U)	52100	--	--

Note: Data postings indicate filtered (F) or unfiltered (U) surface water concentrations (µg/L) exceeding lowest observed effect concentrations (LOECs) for aquatic receptors.

Legend

- Result < NOEC
- NOEC < Result < LOEC
- Result > LOEC
- Site Boundary

Ecological Exposure Areas

Aquatic Exposure Areas

- 9 - FLATHEAD RIVER AREA
- 10 - CEDAR CREEK

Transitional Exposure Area

- 2 - NORTH PERCOLATION POND AREA
- 11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
- 12 - SOUTH PERCOLATION POND AREA

Terrestrial Exposure Area

- 1 - MAIN PLANT AREA
- 3 - CENTRAL LANDFILLS AREA
- 5 - EASTERN UNDEVELOPED AREA
- 6 - NORTH-CENTRAL UNDEVELOPED AREA
- 7 - WESTERN UNDEVELOPED AREA
- 8 - FLATHEAD RIVER RIPARIAN AREA

Surface Water NOEC/LOEC Direct Contact Exceedances Flathead Riparian Area Channel

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-39

Reviewed By: G. Long

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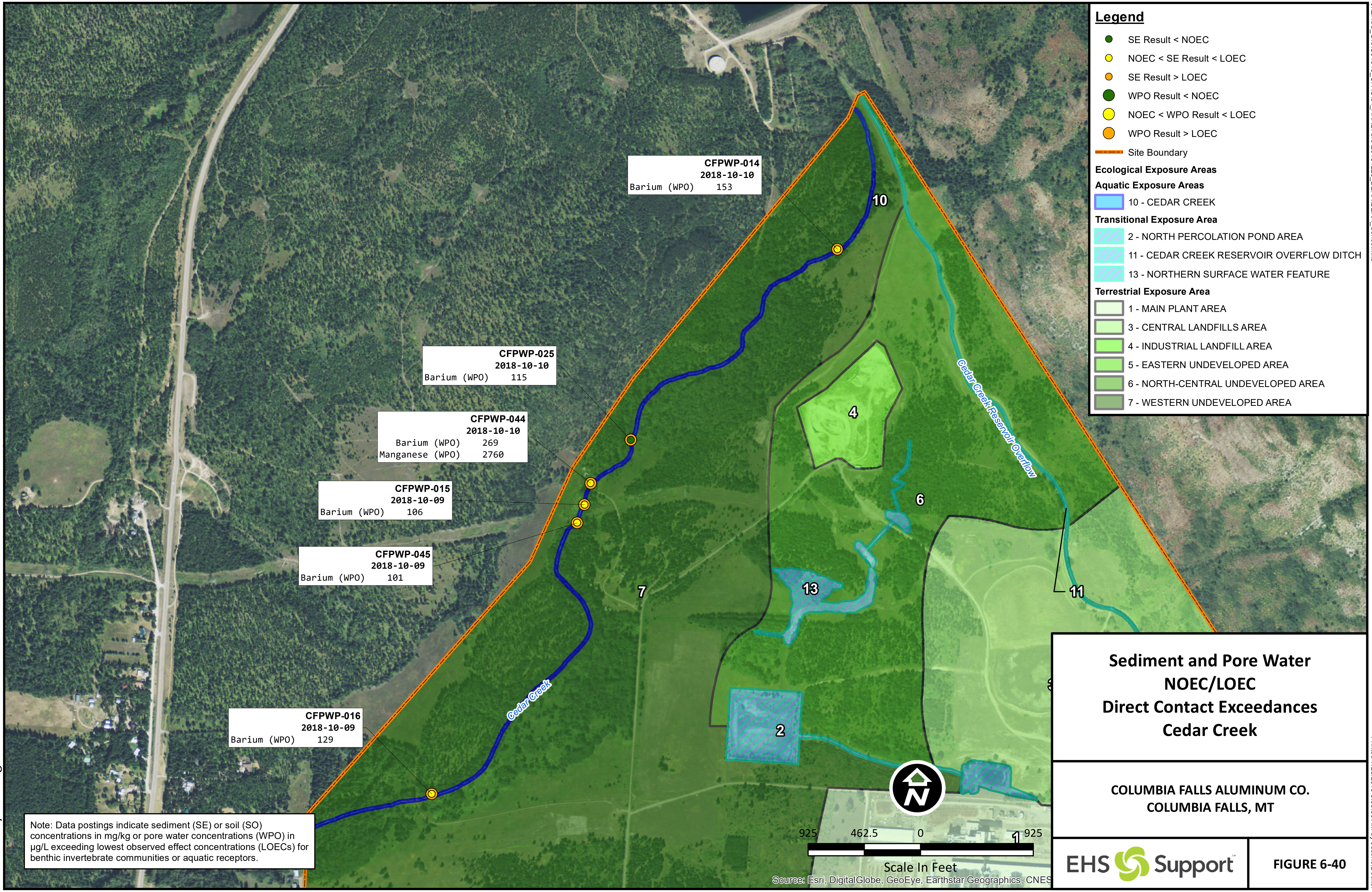

Note: Data postings indicate sediment (SE) or soil (SO) concentrations in mg/kg or pore water concentrations (WPO) in µg/L exceeding lowest observed effect concentrations (LOECs) for benthic invertebrate communities or aquatic receptors.

Sediment and Pore Water NOEC/LOEC Direct Contact Exceedances Cedar Creek

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-40

Reviewed By: G. Long

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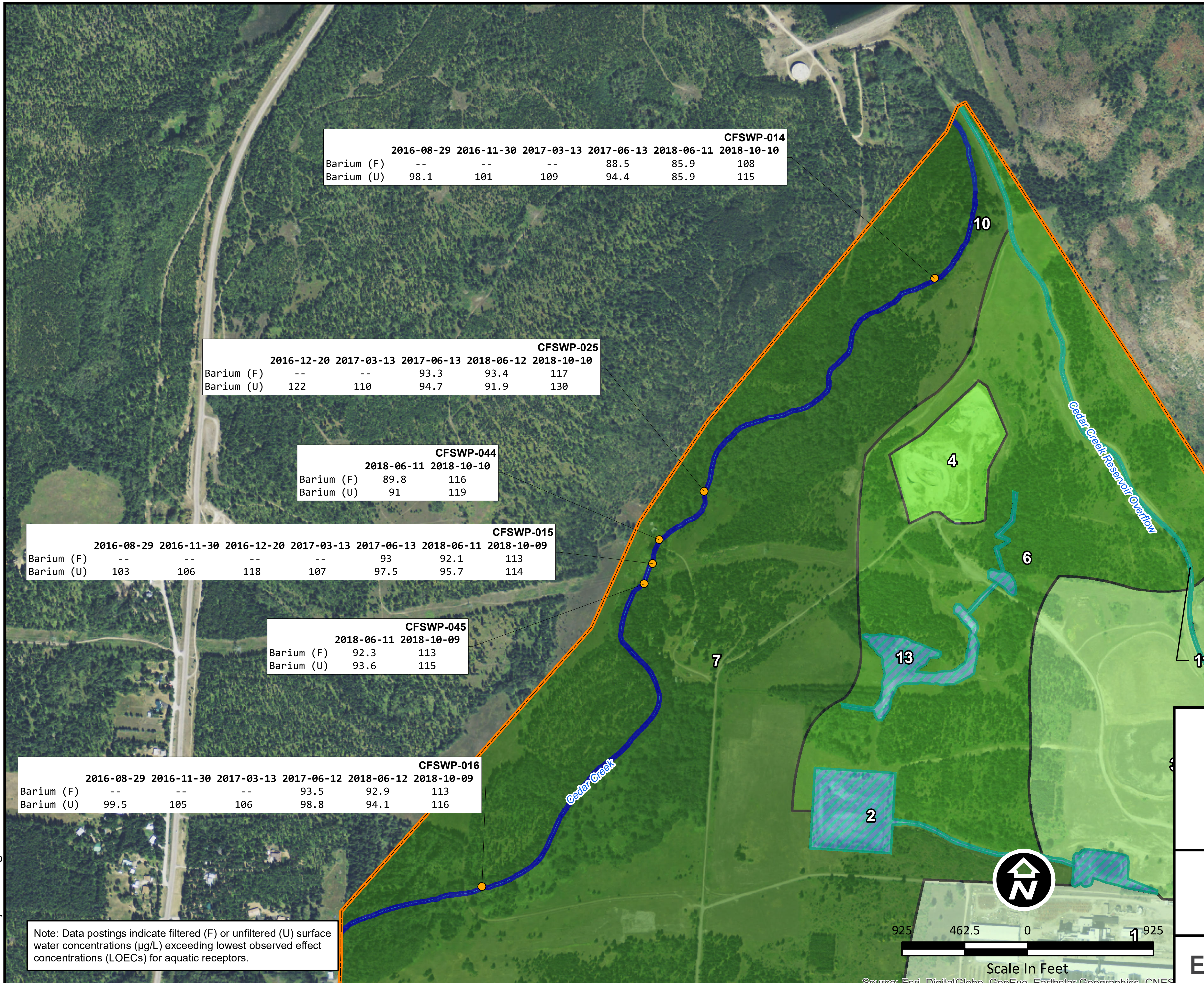

CFSWP-014

	2016-08-29	2016-11-30	2017-03-13	2017-06-13	2018-06-11	2018-10-10
Barium (F)	--	--	--	88.5	85.9	108
Barium (U)	98.1	101	109	94.4	85.9	115

CFSWP-025

	2016-12-20	2017-03-13	2017-06-13	2018-06-12	2018-10-10
Barium (F)	--	--	93.3	93.4	117
Barium (U)	122	110	94.7	91.9	130

CFSWP-044

	2018-06-11	2018-10-10
Barium (F)	89.8	116
Barium (U)	91	119

CFSWP-015

	2016-08-29	2016-11-30	2016-12-20	2017-03-13	2017-06-13	2018-06-11	2018-10-09
Barium (F)	--	--	--	--	93	92.1	113
Barium (U)	103	106	118	107	97.5	95.7	114

CFSWP-045

	2018-06-11	2018-10-09
Barium (F)	92.3	113
Barium (U)	93.6	115

CFSWP-016

	2016-08-29	2016-11-30	2017-03-13	2017-06-12	2018-06-12	2018-10-09
Barium (F)	--	--	--	93.5	92.9	113
Barium (U)	99.5	105	106	98.8	94.1	116

Note: Data postings indicate filtered (F) or unfiltered (U) surface water concentrations (µg/L) exceeding lowest observed effect concentrations (LOECs) for aquatic receptors.

Legend

- Result < NOEC
- NOEC < Result < LOEC
- Result > LOEC
- Site Boundary

Ecological Exposure Areas

Aquatic Exposure Areas

- 10 - CEDAR CREEK

Transitional Exposure Area

- 2 - NORTH PERCOLATION POND AREA
- 11 - CEDAR CREEK RESERVOIR OVERFLOW DITCH
- 13 - NORTHERN SURFACE WATER FEATURE

Terrestrial Exposure Area

- 1 - MAIN PLANT AREA
- 3 - CENTRAL LANDFILLS AREA
- 4 - INDUSTRIAL LANDFILL AREA
- 5 - EASTERN UNDEVELOPED AREA
- 6 - NORTH-CENTRAL UNDEVELOPED AREA
- 7 - WESTERN UNDEVELOPED AREA

Surface Water NOEC/LOEC Direct Contact Exceedances Cedar Creek

COLUMBIA FALLS ALUMINUM CO.
COLUMBIA FALLS, MT

EHS Support

FIGURE 6-41

Reviewed By: G. Long

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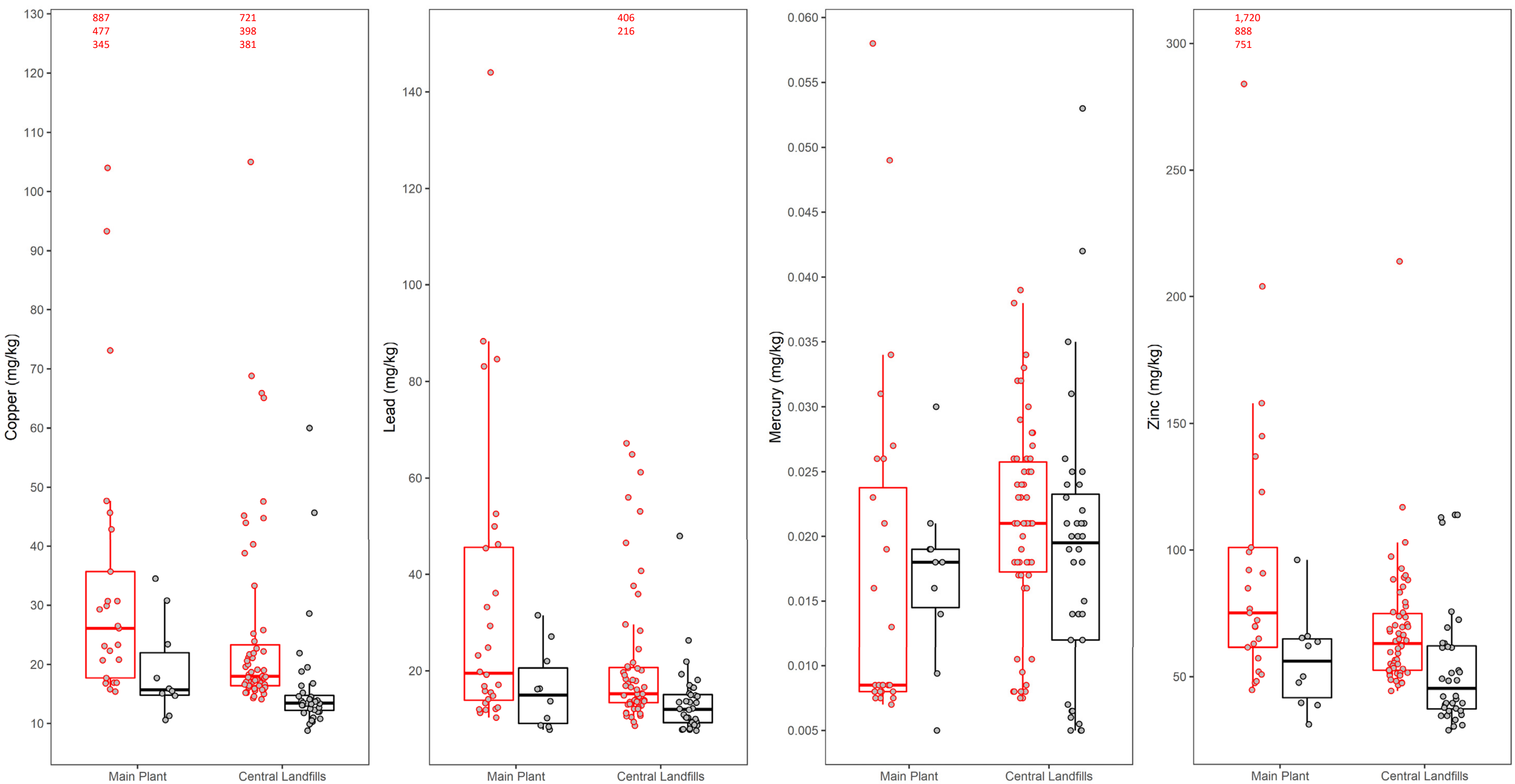


Legend

ISS Sample

Discrete Sample

Notes

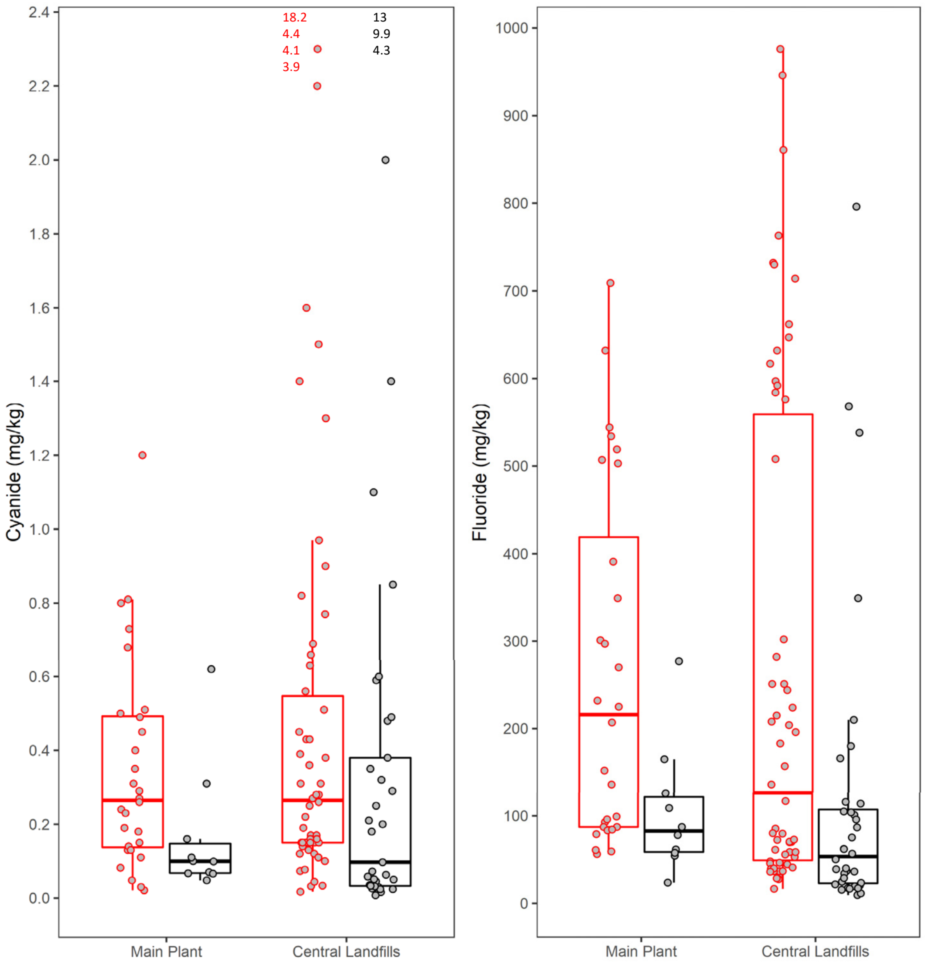
- Non-detects replaced with ½ the MDL.
- High outlier values listed above their respective distribution of results.

FIGURE 7-1

EHS Support

COMPARISON OF SELECT ISS AND DISCRETE SAMPLE RESULTS - METALS

Prepared by:	R. Sleeper	Checked by:	R. Sleeper
Project:	CFAC - BERA	Date:	July 19, 2019



Legend

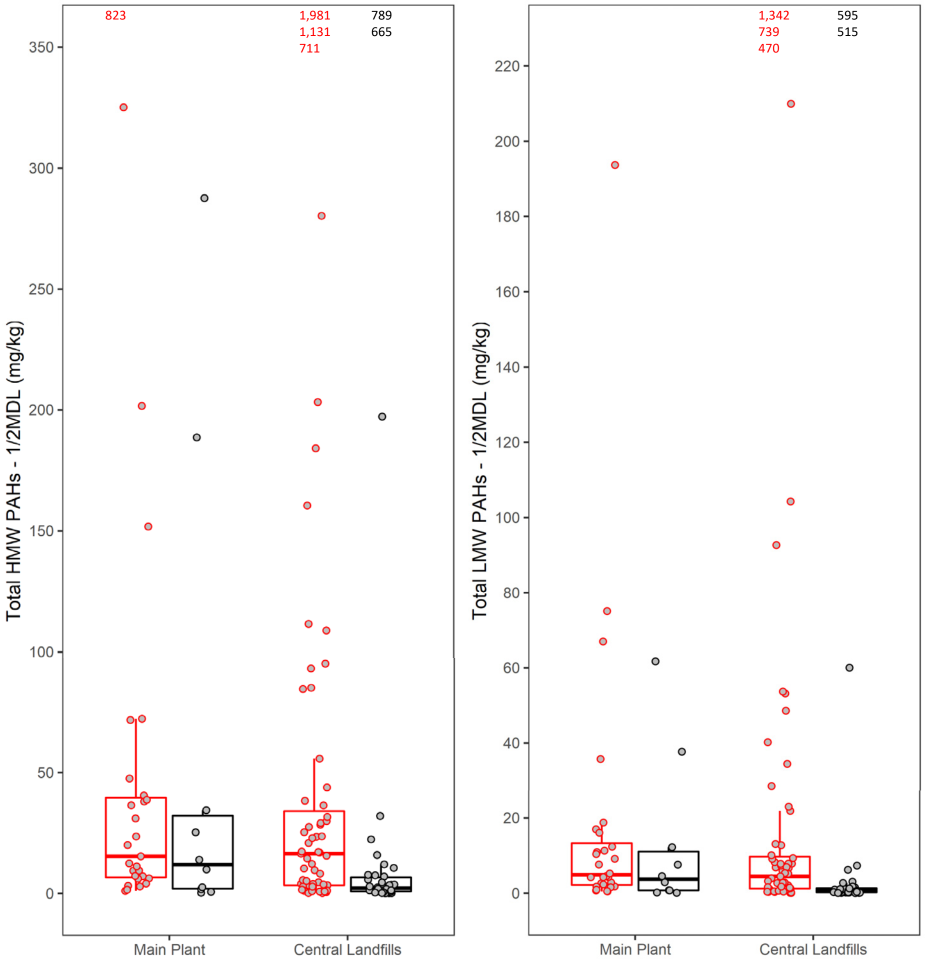
ISS Sample

Discrete Sample

Notes

- Non-detects replaced with ½ the MDL.
- High outlier values listed above their respective distribution of results.

FIGURE 7-2	EHS Support
COMPARISON OF SELECT ISS AND DISCRETE SAMPLE RESULTS – OTHER INORGANICS	
Prepared by: R. Sleeper	Checked by: R. Sleeper
Project: CFAC - BERA	Date: July 19, 2019



Legend

ISS Sample

Discrete Sample

Notes

- Non-detects replaced with ½ the MDL.
- High outlier values listed above their respective distribution of results.
- HMW: High molecular weight PAHs
- LMW Low molecular weight PAHs
- PAHs: Polycyclic Aromatic Hydrocarbons

FIGURE 7-3

EHS Support

COMPARISON OF SELECT ISS AND DISCRETE SAMPLE RESULTS - PAHs

Prepared by: R. Sleeper	Checked by: R. Sleeper
Project: CFAC - BERA	Date: July 19, 2019