# 6 Baseline Risk Assessment

This risk assessment provides the methodology and results for the human health and ecological risk assessment. This assessment follows the protocol outlined in the Risk Assessment Work Plan (RAWP)[1] submitted as Appendix B of the *Work Plan, Remedial Investigation/Feasibility Study, Red Devil Mine, Alaska* (E & E 2011) and the technical memorandum, *Proposed Approach to Evaluating Consumption of Wild Foods at the Red Devil Mine Site, Alaska, Version 2* (E & E 2012).

This baseline risk assessment consists of the following sections:

**Section 6.1, Data Usability:** Provides the evaluation of site data for usability in risk assessment.

**Section 6.2, Human Health Risk Assessment:** Presents the identification of human health COPCs, exposure assessment, toxicity assessment, and risk characterization.

**Section 6.3, Ecological Risk Assessment:** Presents the baseline ecological risk assessment (BERA) based on the revised screening level ecological risk assessment (SLERA) prepared in March 2012. The revised SLERA is provided as Appendix F.

**Section 6.4, Risk-Based Cleanup Levels**: Presents the preliminary cleanup levels based on the results of the HHRA and ERA.

## 6.1 Data Usability

Regional studies, contaminant investigations, and sampling programs associated with cleanup activities have been conducted at and near the RDM site over the past 40 years. A review of historical data usability is presented in Section 1.4.4.

A summary of the history of environmental sampling and monitoring at the RDM site was provided in Section 3.1 of the RI/FS Work Plan (E & E 2011). Five major removal/cleanup actions were performed at the RDM site between 1999 and 2006. These actions have included offsite disposal of hazardous waste and materi-

[1] An acronyms list is provided in Section 6.6

als and onsite consolidation of mine structure debris. To date, all mine structures have been demolished, and three debris burial areas (monofills) have been constructed. The major removal/cleanup actions that have been conducted at the RDM site are summarized in Section 1.4.4, above.

### 6.1.1 Data Usability

Due to the extensive nature of the sampling conducted in 2010 and 2011 for surface soil, subsurface soil, groundwater, sediment, and surface water, data collected for this report are the most current and relevant data for use in the risk assessment. Results from additional vegetation and fish studies also were used. Specifically, data in this risk assessment were derived from the following sources:

- Remedial Investigation (2012) – including data results from the 2010 Limited Sampling Event, 2011 sampling, and 2011 vegetation sampling.
- USGS Fish Tissue Sampling from June 2010 and August 2010 (Matz 2011).
- USGS Mercury Studies (Bailey and Gray 1997; Bailey et al. 2002).

### 6.1.2 Data Usability Criteria

The risk assessment highlights chemicals associated with historical operations that are thought or known to have been released to the environment. A review of existing data and a list of target analytes are provided in Section 1.4.4.

As noted in Chapter 4, analytical data generated from the samples collected in 2010 and 2011, which are used in this chapter to assessment risk and hazards from potential exposure with contaminants at the site, were validated by E & E chemists in accordance with following:

- Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (EPA 2010c).
- Contract Laboratory Program National Functional Guidelines for Organic Data Review (EPA 2008c).
- Guidelines for Data Reporting, Data Reduction, and Treatment of Non-Detect Values (ADEC 2008c).
- Quality assurance guidelines in Standard Operating Procedure BR-0013 for mercury selective sequential extraction analyses (Brooks Rand 2010).
- Quality assurance guidelines in EPA Method 1632 for arsenic speciation analysis (EPA 1998a).
- Quality assurance guidelines in EPA Method 9200.1-86 for arsenic bioaccessibility assays (EPA 2008d).

The results of data validation are presented in Analytical Data Review Summary memoranda for each laboratory data deliverable and are contained in Appendix B. In general, all data generated for the RI are considered usable for the risk assessment, with qualifications.

Consistent with ADEC requirements (ADEC 2008c), the highest concentrations between duplicate and original samples were used in the risk assessment.

## 6.2 Human Health Risk Assessment

### 6.2.1 Overview

This chapter contains the results of the HHRA developed consistent with the protocol outlined in the risk assessment work plan submitted as Appendix B of the *Work Plan, Remedial Investigation/Feasibility Study, Red Devil Mine, Alaska* (E & E 2011) and the technical memorandum, *Proposed Approach to Evaluating Consumption of Wild Foods at the Red Devil Mine Site, Alaska, Version 2* (E & E 2012). This HHRA describes the results of the determination of COPCs (Section 6.2.2), exposure assessment (Section 6.2.3), toxicity assessment (Section 6.2.4), risk characterization (Section 6.2.5), and analysis of uncertainty (Section 6.2.6).

COPC determination identifies which compounds are quantitatively and qualitatively evaluated in the HHRA. The exposure assessment describes how exposures to receptors are quantified for each potentially complete exposure pathway, while the toxicity assessment explains how the toxicity of carcinogenic and noncarcinogenic COPCs is estimated. The information from the exposure and toxicity assessments is then combined to generate quantitative estimates of risk and hazard at the site.

The HHRA report provides a detailed discussion of the uncertainty associated with each step of the HHRA and indicates how each issue may impact the overall risk and hazard estimates. The HHRA was developed to be consistent with federal and state guidance, in addition to information presented in peer-reviewed publications, including, but not limited to, the following documents:

- Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final (EPA 1989).
- Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) (EPA 2004).
- Risk Assessment Guidance for Superfund Volume I, Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment) (EPA 2009c).
- Human Health Evaluation Manual, Supplemental Guidance, "Standard Default Exposure Factors," Interim Final (OSWER Directive 9285.6-02; EPA 1991).
- Exposure Factors Handbook (EPA 1997a; EPA 2011a).
- Child-Specific Exposure Factors Handbook (EPA 2008b).
- ProUCL Version 4.1.00 User Guide (EPA 2010e).
- ProUCL Version 4.1.00 Technical Guide (EPA 2010d).
- Framework for Metals Risk Assessment (EPA 2007i).
- Risk Assessment Procedures Manual (ADEC 2000, 2011)
- Risk Management Criteria for Metals at BLM Sites (BLM 2004).

### 6.2.2 Selection of Contaminants of Potential Concern

COPCs were identified based on the following criteria:

1. Screening values based on toxicological characteristics of each chemical, and
2. Evaluation of essential nutrients.

This approach is consistent with the EPA document *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989) and the ADEC *Risk Assessment Procedures Manual* (2000; 2011) and is discussed in further detail throughout this section.

As described in Chapter 4, a number of inorganic compounds were found at the RDM site in background samples for all media. For many of these compounds, the levels are elevated above risk-based screening criteria. Consistent with EPA policy (EPA 2002a), no COPC was eliminated based on comparison to background concentrations. Section 6.2.5.4 includes an analysis of contribution from elevated background concentrations to overall risks and hazards at the site.

#### 6.2.2.1 Screening Values

Maximum site concentrations in each medium (soil, sediment, groundwater, and surface water) were compared to risk-based screening concentrations (RBSCs). As noted in the conceptual site model (CSM) (discussed below in Section 6.2.3.1), human receptors that may have contact with exposure media at the RDM site include future onsite residents, recreational or subsistence users, and industrial or mine workers. Exposure media include soil, sediment, surface water, groundwater, and biota. For exposure assessment, tailings are treated as soil or sediment based on their location and potential for exposure.

Soil RBSCs include EPA Regional Screening Levels (RSLs) for residential soils (EPA 2011b) adjusted to a cancer risk of $10^{-6}$ or a hazard quotient (HQ) equal to 0.1, one-tenth of the direct contact and inhalation Alaska Method 2 soil cleanup level for the Under 40 inch zone (18 AAC 75.341; values provided in Appendix B of the *Cumulative Risk Guidance* [ADEC 2008b]) and the BLM's Risk Management Criteria for Metals at BLM sites for the resident scenario (BLM 2004).

There are no readily available screening criteria from the EPA or ADEC for human exposure to sediments. Soil criteria (e.g., RSLs and one-tenth Method 2 values) were used as sediment RBSCs. The BLM (2004) provides screening criteria for people exposed to sediment while camping. These values, in addition to those listed for soil, were used for sediment. Red Devil Creek sediments, as well as both near-shore and off-shore Kuskokwim River sediment samples were screened against these RBSC to ensure that all COPCs were identified, although human receptors have no direct exposure to off-shore Kuskokwim River sediments.

Groundwater RBSCs include one-tenth Alaska groundwater cleanup levels (18 AAC 75.345, Table C), EPA RSLs (EPA 2011) for tap water adjusted to a cancer risk of $10^{-6}$ or an HQ equal to 0.1, and federal MCLs (EPA 2009b). COPCs exceeding any of the applicable screening criteria were included in the assessment for quantitative determination of risk.

Groundwater RBSCs were conservatively applied to surface water to determine surface water RBSCs. Comparison of surface water results to water quality standards for surface water (18 AAC 70) and ambient water quality criteria (EPA 2009a) are discussed in Chapter 7. For groundwater and surface water, total and dissolved metal results were evaluated separately in the COPC screening. Consistent with EPA *Risk Assessment Guidelines for Superfund, Part A* (1989), data from unfiltered water samples (total metals) were used to estimate exposure in the HHRA.

If the maximum site concentration did not exceed any of the RBSCs for each medium, the compound was eliminated as a COPC. There are no RBSCs for 4-bromophenyl phenyl ether, so it was retained as a COPC for further evaluation.

Bioaccumulative compounds detected in sediment and surface water were retained as COPCs regardless of their comparison to screening criteria. ADEC defines bioaccumulative compounds as those that have a bioconcentration factor equal to or greater than 1,000 for organic compounds or are identified by the EPA (2000a) as bioaccumulative inorganic compounds (ADEC 2010). The following compounds were identified as COPCs in sediment and surface water solely based their bioaccumulative properties (i.e., they did not exceed an RBSC): cadmium, copper, lead, methylmercury, selenium, silver, and zinc.

There are no available screening criteria that are representative of subsistence use of biota. Therefore, biota was not compared to screening benchmarks. For evaluating consumption of fish, any inorganic compound identified as a COPC in sediment or surface water, including bioaccumulative chemicals, was evaluated as a COPC in fish. For evaluating consumption of land mammals, birds, berries and plants, and inorganic compounds identified as COPCs in surface or subsurface soil were included as a COPC for this biota.

#### 6.2.2.2 Essential Nutrients

The EPA (1989) recommends removing chemicals from further consideration if they are considered “essential nutrients”; present at low concentrations (i.e., only slightly elevated above naturally occurring levels); and toxic only at very high doses. The essential nutrients that were eliminated from the list of COPCs are magnesium, calcium, sodium, and potassium. These chemicals are toxic only at very high doses and are expected to be present at concentrations that would not be due to chemical sources at the RDM site. In addition, no screening criteria were available from the sources identified in Section 6.2.2.1.

#### 6.2.2.3 Final Compounds of Potential Concern

The results of the surface and subsurface soil screening are presented in Tables 6-1 and 6-2. Results of the sediment, groundwater, and surface water screening are presented in Tables 6-3, 6-4, and 6-5, respectively[2]. The final list of COPCs is provided in Table 6-6.

For compounds that had no detected result, the detection limits were compared to the RBSC as described in Section 6.2.2.1, to ensure that detection limits were sufficiently low enough to identify any potential risk drivers at the site. For soil (both surface and subsurface soil) and sediment results, the minimum detection limits for all non-detected compounds were below the RBSC.

For groundwater and surface water results, there were a number of analytes with detection limits that exceeded the RBSC: p-chloroaniline, bis(2-chloro-1-methylethyl) ether, bis(2-chloroethyl)ether, hexachlorobenzene, 2,4-dinitrotoluene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, 4,6-dinitro-o-cresol, dibenz(a,h)anthracene, benz(a)anthracene, N-nitroso-di-N-propylamine, N-nitrosodimethylamine, hexachlorobutadiene, pentachlorophenol, naphthalene, 3,3’-dichlorobenzidine, and nitrobenzene. Of these, the following compounds had detection limits very close to the RBSC (within an order of magnitude): p-chloroaniline, bis(2-chloro-1-methylethyl) ether, 2,4-dinitrotoluene, benzo(k)fluoranthene, 4,6-dinitro-o-cresol, hexachlorobutadiene, naphthalene, 3,3’-dichlorobenzidine, and nitrobenzene.

Although the following nine compounds had detection limits above the RBSC, these compounds are not expected to be found in groundwater or surface water at appreciable levels based on either their chemical properties or use at the site: bis(2-chloroethyl)ether, hexachlorobenzene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, benz(a)anthracene, N-nitroso-di-N-propylamine, N-nitrosodimethylamine, and pentachlorophenol. In addition, none of these compounds were identified as COPCs in soil or sediment. Based on this, it is not expected that elevated detection limits would have an appreciable impact on overall risk at the site. The impacts of the detection limits are discussed in Section 6.2.6.

### 6.2.3 Exposure Assessment

The purpose of the exposure assessment is to quantify potential exposures of human populations that could result from contact with COPCs from the RDM site. Each complete exposure pathway contains four necessary components:

- A contaminant source and a mechanism of COPC release.
- An environmental medium and mechanism of COPC transport within the medium.
- A potential point of human contact with the affected environmental media, also called the exposure point.
- An exposure route.

[2] All tables for Chapter 6 are provided at the end of the chapter

The exposure assessment characterizes the exposure setting; identifies receptors that may be exposed; identifies direct and indirect pathways by which exposures could occur (i.e., pathways for direct ingestion of COPCs from soil and indirect uptake from ingestion of harvested wild food items); and describes how the rate, frequency, and duration of these exposures is estimated. The exposure assessment includes the following subsection components:

- A CSM
- Exposure scenarios
- A quantification of exposure.

#### 6.2.3.1 Conceptual Site Model

The CSM for the RDM site is presented in Figure 6-1 and discussed in this section. The CSM has not changed from the preliminary CSM presented in the RAWP (E & E 2011). The RDM site is located on BLM land on the southwest bank of the Kuskokwim River, approximately 2 miles southeast from the village of Red Devil. Public access is not restricted, but the mine is in a remote part of Alaska and only has occasional visitors. Access to the site is obtained by boat/barge on the Kuskokwim River, by means of an airstrip at Red Devil Village, and dirt roads and woodland trails via all-terrain vehicles (ATVs) during summer months.

Contaminants from mine waste, groundwater, or air emissions may enter the surface water or sediment through surface water runoff, erosion and transport by surface water, or direct placement of waste and tailings in Red Devil Creek. Contaminants may enter groundwater through infiltration or leaching from source areas. Contaminants may also be directly released to soils, erode from sources, or be deposited from air emissions during previous mine operations. Volatile chemicals in soil (i.e., mercury) may volatilize into the air; other contaminants may be entrained in fugitive dust. Contaminants may bioaccumulate from soils, surface water, or sediment into plants, animals, and fish. See Section 5 for additional information regarding contaminant fate and transport.

Currently, no one lives permanently or temporarily at the RDM site. Residents of Red Devil Village and nearby communities currently use the site for recreational and subsistence activities. Future use of the site is unknown but may include the site remaining as an occasional recreational or subsistence harvest area. Potential changes in land use could result in the site being used for industrial or mining activities or as a residential area.

Based on the known and possible future land uses at the RDM site, the following receptors were selected to represent current or potential future use of the site:

- Future Onsite Resident (adult and child)
- Recreational or Subsistence User (adult and child)
- Industrial/Mine Worker (adult only).

Each scenario is discussed in further detail in this subsection.

**Future Onsite Adult and Child Resident**

The future adult and child residential scenario represents potential exposures for a hypothetical person who lives at the site and leaves the site for two weeks per year. It is assumed that the adults would live and work at the site and the children would live at the site and go to school at the site. It is assumed that the drinking water supply would be from groundwater. Other assumptions are detailed below. Residents may be exposed to COPCs in groundwater through ingestion and dermal contact. In addition, people may be exposed to volatile COPCs (i.e., elemental mercury) in groundwater during household uses of groundwater (e.g., showering). Indirect exposure through consumption of native wild foods such as fish, game, and plants through subsistence activities is included in this scenario; however, only a percentage of native food consumed would be anticipated to be gathered from the site. Adults and children may come in contact with surface water by wading or playing in Red Devil Creek. They may come into contact with sediments during wading or playing near Red Devil Creek or near the shores of the Kuskokwim River. The adult and child resident scenario includes the following exposure pathways:

- Dermal (skin) contact with surface water from Red Devil Creek.
- Dermal (skin) contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Ingestion of and dermal contact with groundwater.
- Incidental ingestion of and dermal contact with soil.
- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals from soil.
- Inhalation of volatile chemicals in groundwater.

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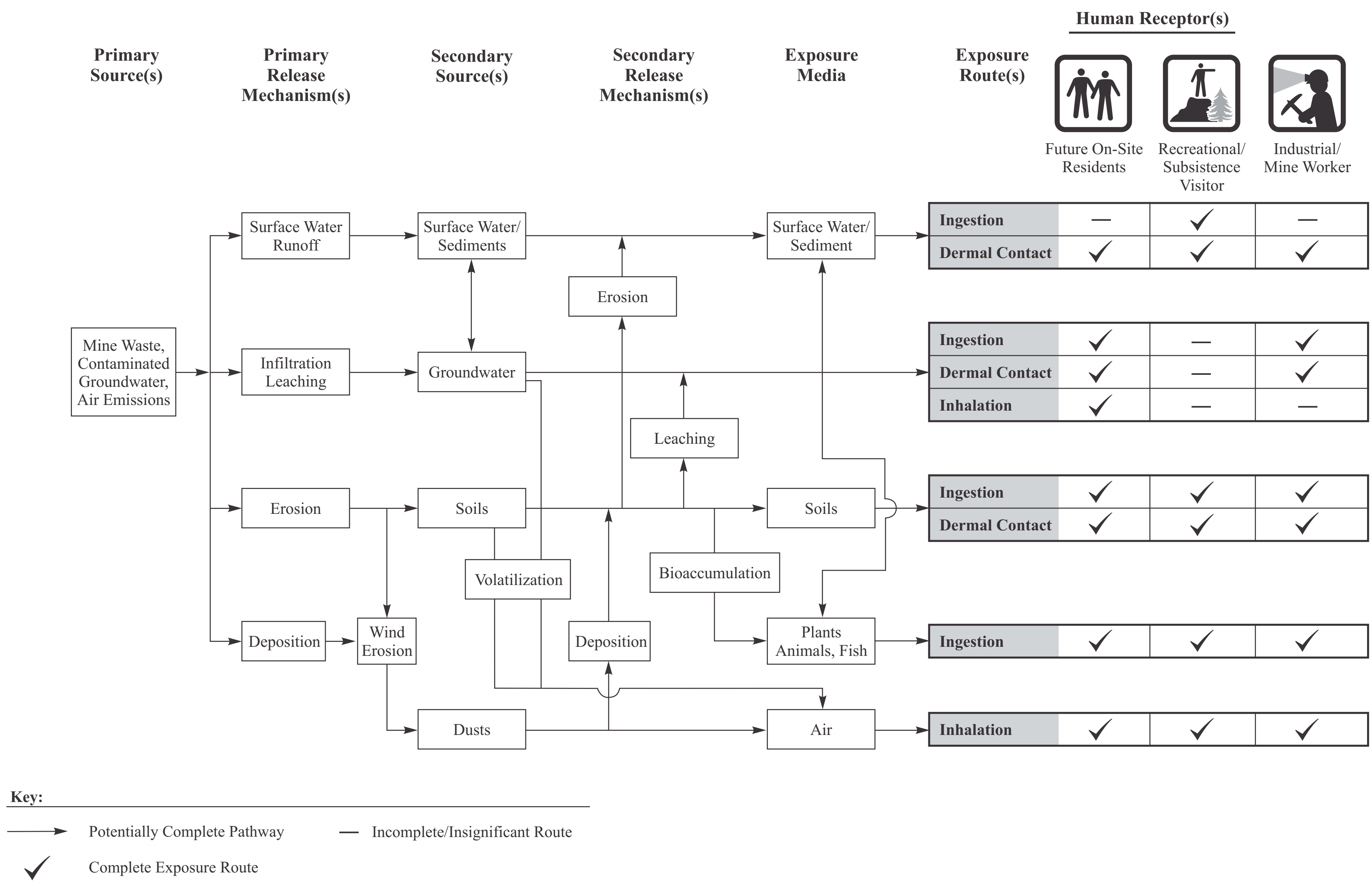


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RED DEVIL MINE

Figure 6-1
HUMAN HEALTH CONCEPTUAL SITE MODEL FOR RED DEVIL MINE SITE

| Date: | Drawn by: | |
| --- | --- | --- |
| 4/2/12 | AGM | 02:001096.0070.08TTO\Fig6-1.cdr |

### Recreational Visitor or Subsistence User

Recreational visitors and subsistence users would visit the site a portion of the year during harvest time and presumably camp in the area. It is assumed that recreational or subsistence users would access the site via ATVs. It is assumed that they would be exposed during the period they were onsite and that they would obtain drinking water from Red Devil Creek. It is also assumed that the recreational or subsistence user would consume local plants and hunt game or catch fish from the site. However, only a percentage of total wild food consumed by the recreational user or subsistence user would be gathered from the site. Therefore, it is assumed that the recreational or subsistence user could be exposed to contaminants at the RDM site through the following pathways:

- Ingestion of and dermal contact with surface water from Red Devil Creek.
- Dermal contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Incidental ingestion of and dermal contact with soil.
- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals.

### Industrial/Mine Worker

If the RDM site is redeveloped in the future as a mine or industrial facility, it is assumed that industrial or mine workers would work at the site and live in nearby Red Devil Village. It is assumed that the drinking water supply would come from groundwater during work times. It is also assumed the workers would fish, hunt, and gather edible plant material. Therefore, indirect exposure through consumption of wild foods such as fish, game, and plants is included in this scenario; however, only a percentage of food is assumed to be gathered from the site. The worker scenario includes the following exposure pathways:

- Dermal (skin) contact with surface water from Red Devil Creek.
- Dermal (skin) contact with sediments from Red Devil Creek and the near-shore of the Kuskokwim River.
- Ingestion of and dermal contact with groundwater.
- Incidental ingestion of and dermal contact with soil.
- Ingestion of native wild foods.
- Inhalation of dust or volatile chemicals.

### 6.2.3.2 Quantification of Exposure

In the exposure quantification portion of the HHRA, estimates are made regarding the magnitude, frequency, and duration of exposure for each complete pathway identified above. For discussion, this portion can be divided into the following sequential tasks:

- Determination of exposure units.
- Estimating exposure point concentrations (EPCs).
- Calculating the amount of COPCs potentially taken into the body (dose).

### Exposure Units

Exposure units can be designated based on different uses of subareas within the site or the uneven distribution of contamination across the site.

For residents, soil and subsurface soil was divided into three separate exposure units: Surface Mined Area (SMA), the Main Processing Area (MPA) and the Red Devil Creek Downstream Alluvial Area (DA), based on historical operations at the site resulting in differing concentrations. Figure 4-1 in Section 4 shows the geographic areas of the site. Antimony, arsenic, and mercury are known COPCs at the site. Table 6-7 compares the concentration ranges for antimony, arsenic, and mercury and averages for the three exposure units and geographical areas.

The SMA exposure unit consists of 60 samples (including duplicates); this includes surface soil samples and subsurface soil sample to a depth of 15 feet bgs. The SMA exposure unit incorporates the following geographic areas, as depicted on Figure 4-1:

- Dolly Sluice and Delta (surface soil n=3; subsurface soil n=8)
- Rice Sluice and Delta (surface soil n=3; subsurface soil n=6)
- Surface Mined Area (surface soil n=32; subsurface soil n=8)

The MPA exposure unit consists of 232 surface and subsurface soil samples, including duplicates. The MPA exposure unit incorporates the Post-1955 Main Processing Area and Pre-1955 Main Processing Area (surface soil n=85; subsurface soil n=147), as depicted on Figure 4-1

The DA exposure unit consists of 34 surface and subsurface soil samples in the Red Devil Creek Downstream Alluvial Area and Delta (surface soil n=11; subsurface soil n=23).

For recreational/subsistence users and mine workers, it is assumed that recreational and subsistence activities would be equally spread throughout the site. Therefore, for these receptors, the full site area was treated as a single exposure unit.

#### 6.2.3.2. Estimation of Exposure Concentration

The concentrations of COPCs to which human receptors potentially are exposed over time were estimated according to EPA guidance (EPA 2006b, 2010d). The EPA (1992) and ADEC (2011) indicate that a 95 % upper confidence limit (UCL) on the mean of COPC concentrations should be used as the EPC. Inherent in this approach is the assumption that receptors that contact an environmental medium containing a COPC do so randomly. Thus, an estimate of average concentration (or in this case the upper bound of the average) is the concentration to which a receptor might be exposed. Maximum concentrations in groundwater were also used to evaluate risk at the site, consistent with ADEC policy (ADEC 2011).

To determine the 95 % UCL, the EPA's ProUCL program, version 4.1.00 (EPA 2010d) was used. ProUCL 4.1 includes goodness-of-fit tests (e.g., normal, lognormal, and gamma) for data sets with and without NDs. For data sets with NDs, ProUCL 4.1 can create additional columns to store extrapolated values for NDs obtained using ROS methods, including normal ROS, gamma ROS, and lognormal ROS (robust ROS) methods. ProUCL 4.1 also has parametric (e.g., maximum likelihood estimate, t-statistic, gamma distribution), nonparametric (e.g., Kaplan-Meier), and computer intensive bootstrap (e.g., percentile, bias-corrected accelerated) methods to compute UCLs for uncensored data sets and also for data sets with ND observations.

The calculated soil EPCs, including distribution and EPC statistics, for the SMA, MPA, and DA exposure units, as derived using ProUCL, are provided in Tables 6-8 through 6-10. The soil EPCs for the site as a whole, as used for the recreational/subsistence user and the mine worker scenarios, are provided in Table 6-11.

Calculated EPCs for sediment, surface water, and groundwater are provided in Tables 6-12 through 6-14.

As indicated in Chapters 3 and 5, groundwater generally flows toward Red Devil Creek and the Kuskokwim River. As such, any impacts to groundwater in the MPA and DA are not expected to affect groundwater concentrations in the SMA, but groundwater within the SMA may be expected to affect groundwater in the MPA and/or the DA. Therefore, for the resident in the MPA and DA exposure units, groundwater EPCs were calculated based on groundwater concentrations in all wells that lie within the MPA, DA, and SMA. For the SMA exposure unit, the groundwater EPCs were based on the results from the single monitoring well located within the SMA (MW29).

In the case of EPCs for wild food and air (both from volatiles and particulates), fate and transport modeling was used in conjunction with the statistical analysis of the environmental data to determine the EPC values. Determination of concentrations in local food resources (plants, fish, and wildlife) is based on concentrations of COPCs in slimy sculpin, green alder bark, and white spruce needles, as discussed in Section 6.2.3.7. The EPCs for slimy sculpin, green alder bark and white spruce needles are presented in Tables 6-15, 6-16, and 6-17, respectively.

#### 6.2.3.3 Calculation of Intake

Potential exposures to the receptors described in the above scenarios were quantified using intakes (or dose), which are expressed as the amount of COPCs (in milligrams [mg]) internalized per unit body weight (in kilograms [kg]) per unit time (in days). That is, estimated intakes are generally provided in units of milligrams per kilogram per day (mg/kg-day). When evaluating carcinogenic COPCs, the intake is referred to as the lifetime average daily intake (LADI), because the intake is averaged over a lifetime.

The generic equation and variables for calculating chemical intakes are described below:

$$I = \frac{C \times CR \times EF \times ED}{BW \times AT}$$

Where:

| | | |
|---|---|---|
| I | = | Intake; the amount of chemical at the exchange boundary (mg/kg body weight/day). |
| C | = | EPC in specific media (e.g., milligrams per liter of water). |
| CR | = | Contact rate; the amount of contaminated medium contacted per unit time or event (e.g., liters per day). |
| EF | = | Exposure frequency, which describes how often exposure occurs (days per year). |
| ED | = | Exposure duration, which describes how long exposure occurs (years). |
| BW | = | Body weight; the average body weight over the exposure period (kg). |
| AT | = | Averaging time; the period over which exposure is averaged (days). |

Exposure to carcinogenic compounds was evaluated based on exposure to a combined child and adult receptor. The LADI was calculated using age adjustments to account for the total exposure duration. Specifically, the LADI was calculated as shown in the following general intake equation:

$$LADI = \frac{C}{AT} \times \left( \frac{EDc \times EFc \times CRc}{BWc} + \frac{(EDa - EDc) \times EFa \times CRa}{BWa} \right)$$

Where:

| | | |
|---|---|---|
| $CR_{a\ or\ c}$ | = | Contact rate for adult or child (varies). |
| $EF_{a\ or\ c}$ | = | Exposure frequency for adult or child (days/year). |
| $ED_{a\ or\ c}$ | = | Exposure duration for adult or child (years). |
| $BW_{a\ or\ c}$ | = | Body weight for adult or child (kg). |

These generic equations were modified to account for scenario-specific exposures to COPCs. For the inhalation route of exposure, intake is depicted as an exposure concentration (EC; EPA 2009c).

For dermal exposure to COPCs in water, the dermally absorbed dose was determined using equations and chemical-specific parameters from the EPA's Dermal Assessment Guidance (2004).

Dermal contact with groundwater and surface water inorganic COPCs was evaluated consistent with the EPA's Risk Assessment Guidance for Superfund (RAGS) Part E (2004). Specifically, intake was calculated as shown in the following equation. The absorbed dose per event ($DA_{event}$) for inorganic compounds was calculated using the following equation:

$$DA_{event} = Kp \times CW \times t_{event} \times CF$$

Where:

$DA_{event}$ = Absorbed dose per event (milligrams per square centimeter per event)
Kp = Dermal permeability coefficient of compound in water (centimeters per hour/), provided in Table 6-18
$t_{event}$ = event duration (hour per event)
Cw = chemical concentration in water based on unfiltered samples (milligrams per liter)
CF = conversion factor, 0.001 liters per cubic centimeter

The only organic COPC identified in groundwater was bis(2-ethylhexyl)phthalate, which is not recommended for quantitative evaluation of the dermal exposure pathway per EPA (2004). Naphthalene and 1-methylnapthalene were identified as COPCs in surface water. 1-methylnaphthalene is not recommended for quantitative evaluation for the dermal exposure pathway per EPA (2004). The following equation was used to determine the $DA_{event}$ for naphthalene, where the event duration is less than the lag time:

$$DAevent = 2FA \times Kp \times Cw \times CF \times \sqrt{\frac{6 \times \tau event \times tevent}{\pi}}$$

Where:

FA = fraction absorbed water, 1 for naphthalene
$T_{event}$ = lag time per event (hours per event), 0.56 hours per event for naphthalene
$t_{event}$ = event duration (hours per event)

The dermal absorption ($ABS_{dermal}$) values were obtained from the EPA's RAGS *(Part E, Supplemental Guidance for Dermal Risk Assessment)*, Exhibit 3-4 (2004) and are presented in Table 6-18. Absorption values are available for only some of the COPCs. The dermal pathway was not evaluated quantitatively for compounds without $ABS_{dermal}$ values. This approach is consistent with the EPA's recommendations (2004).

The intakes calculated for each scenario are intended to represent the reasonable maximum exposure (RME) conditions. An RME scenario is a combination of high-end and average exposure values and is used to represent the highest exposure that is reasonably expected to occur. The RME scenario is a conservative exposure scenario that is plausible yet well above the average exposure level.

For soil ingestion and dust inhalation of arsenic, soil intakes are multiplied by an estimate of relative bioavailability to quantify the level of arsenic that reaches systemic circulation. See Section 6.2.3.6 for additional information on arsenic bioavailability.

Exposure route and media specific intake equations and proposed values for exposure parameters are presented in Table 6-19 and are discussed in this section.

#### 6.2.3.4 Exposure Factors

In addition to intake rates, exposure factors for body weight (BW), exposure frequency (EF), exposure duration (ED), and averaging time (AT) are included in the intake equation. Values used for BW, EF, ED, and AT vary among scenarios. For exposure pathways related to skin exposure, an additional variable for skin surface area (SA) may be included in the intake equation. Intake rates used to estimate exposure are discussed in Section 6.2.3.3.

**Body Weight**

A BW value of 70 kg (154 pounds) is used for all adults and is based on an average of male and female adult BWs. The average BW for all children is 15 kg (33 pounds) for a child up to age 6. These values are consistent with EPA and ADEC guidance (EPA 1989, 2002b; ADEC 2011).

**Exposure Frequency and Time**

The EF describes how often someone may have contact with affected media over a one-year period. The EPA (1989, 1991) recommends an assumption that the future resident (adults and children) may be exposed through a specific exposure pathway for 350 days per year. The underlying assumption is that people spend at least two weeks at a location other than the exposure scenario location each year (i.e., a two-week vacation). Due to snow cover during winter months, the ADEC recommends that the EF for soil exposure be adjusted to 270 days per year for sites in the under 40-inch precipitation region, which includes the RDM site (ADEC 2011). This adjusted EF is used for soil contact (ingestion and dermal) for the adult and child future onsite resident.

An EF of 250 days per year is used for the mine worker, consistent with EPA and ADEC recommendations (ADEC 2011; EPA 2002b) for an industrial scenario. This value assumes that workers are onsite an average of five days per week for 50 weeks (assuming two weeks of vacation). Alternatively, mining operations in remote Alaska may use a two-weeks-on and two-weeks-off work schedule. The ED of 250 days recommended by the EPA and ADEC provides a conservative estimate under this scenario, as well. The ED of 250 days per year is used for both soil and groundwater exposure, since people would potentially only be exposed to site-related contaminants in either media while at the site.

For exposure to surface water, the event frequency for the residential and mine worker scenarios was determined based on best professional judgment, assuming that people would wade in the water no more than half the days during the summer months (mid-May through mid-September). This results in approximately 60 days per year for the residential scenario and 40 days per year for the mine worker scenario. It is assumed that true exposure would be less than this. For the recreational/subsistence user, EF to surface water during recreational/subsistence activities is derived based on the maximum fraction ingested from the site (FI) for all wild food resources (0.33, as determined in Section 6.2.3.5) multiplied by the residential EF of 60 days per year for surface water. The resulting EF for the recreational and subsistence user is set at 20 days per year.

For the recreational/subsistence user, EF to soil during recreational/subsistence activities was derived based on the maximum FI (0.33) multiplied by the residential EF, 270 days per year for soil. The resulting EF for the recreational and subsistence user is set at 90 days per year. It is assumed that children will accompany their parents or adults during their time onsite. This value was also used for the resident and mine worker scenario, since residential exposure to sediment will occur during similar recreational activities at the site.

For the inhalation route of exposure, the exposure time (i.e., time per day exposed to contaminants in air) is also included with the EF. For inhalation of volatiles in soil, the exposure time is equal to 24 hours per day for residents and recreational/subsistence users and 8 hours per day for workers, consistent with the EPA's recommendations (EPA 2009c). For inhalation of volatile COPCs in groundwater during showering, an exposure time of 45 minutes per showering event (0.75 hours) is used for both the adult and child residential scenarios. The EPA $95^{th}$ percentile exposure time for showering for children is 44 minutes and for adults is 45 minutes (EPA 2009c). Therefore, 45 minutes is an appropriate estimate for both scenarios.

### Exposure Duration

The ED is the length of time in years for which someone may be exposed through a specific exposure pathway. An ED of six years was assumed for all child scenarios (EPA 1989, 2002b; ADEC 2011) representing a child up to 6 years of age. Exposures occurring beyond age 6 are accounted for in the adult exposure scenarios.

The default ED for the adults is 30 years for future onsite residents (EPA 2002b; ADEC 2011). The ADF&G (Brown et al. 2012) completed a survey in Red Devil Village (see Section 6.2.3.5). This survey included questions regarding how long a respondent had lived at the current location in Red Devil Village and from where he or she moved (i.e., form a community in Alaska or state in the United States or other country) prior to residing in the current location. It is assumed that the residential patterns of a new community established near the RDM site would be similar to the pattern seen in residents of Red Devil Village. Based on the

ADF&G report, on average, residents lived in Red Devil approximately 23 years. Therefore, an ED of 30 years was considered representative for the adult residential and recreational/subsistence user ED.

The default ED for a commercial/industrial worker is 25 years (ADEC 2011), but time in mining occupations is substantially less than that. The median occupational tenure for mining activities is 8.6 years (EPA 1997a). For consistency with EPA and ADEC guidance, a conservative ED of 25 years was used for a mine worker.

For carcinogens, the ED for residential and recreational/subsistence user scenarios is calculated as an aggregate of child and adult exposure; the first six years of the ED is based on the child intake and the remaining time is based on an adult intake (24 years), as described in Section 6.2.5.1.

### Averaging Time

The AT is the number of days over which an exposure is averaged. The AT varies depending on whether the COPC in the affected media is a carcinogen or noncarcinogen. A longer AT is used for carcinogenic COPCs to account for the long latency period before exposure effects are seen. The EPA (1989) recommends an AT of 70 years × 365 days per year, or 25,550 days, for exposure to carcinogenic COPCs for the residential scenarios. For noncarcinogenic COPCs, the EPA (1989) recommends using an AT equal to the ED. These values are used in the risk assessment. For the ingestion and dermal routes of exposure, the averaging time is displayed in days. For the inhalation route of exposure, the averaging time is displayed in hours (EPA 2011a).

### Surface Area of Skin

COPCs are absorbed by the skin through contact with soil and water. Dermal (skin) absorption of COPCs in soil may occur during outdoor activities. COPCs in groundwater may be absorbed by the skin during activities such as bathing or showering. COPCs in surface water may be absorbed through limited contact with surface water during recreational activities (e.g., washing hands or limited play in the creek).

Exposure to COPCs is affected by the surface area of skin coming into contact with the contaminated soil or sediment and the adherence of the soil to the skin. For skin contact with soil, the EPA (2004) and ADEC (2011) recommend using a skin surface area of 5,700 square centimeters ($cm^2$) for an adult wearing a short-sleeved shirt, shorts, and shoes, with exposed skin surface limited to the head, hands, lower legs, and forearms. The recommended skin surface area for children is 2,800 $cm^2$, for exposed head, hands, lower legs, and forearms (EPA 2004; ADEC 2011). These values are used for the residential and recreational/subsistence user scenarios. The SA of 3,300 $cm^2$ (ADEC 2011; EPA 2004) for an industrial worker is used for the mine worker scenario.

Soil-to-skin adherence factor (AF) assumptions are based on values provided by the ADEC (2011) and in the EPA's Dermal Assessment Guidance (2004) and are consistent with residential and industrial scenarios, as appropriate. No values are available for sediment-to-skin AFs, so the soil-to-skin AFs is conservatively used for sediment dermal exposure, as well.

For dermal absorption of COPCs in groundwater during showering or bathing activities, surface area values of 18,000 $cm^2$ for adults and 6,600 $cm^2$ for children are used, consistent with the RME recommendations presented by the EPA (2004). For each showering or bathing event the duration is equal to 0.25 hours per event for adults and 0.33 hours per event for children (EPA 2004).

Dermal absorption of COPCs in surface water could occur while people wade or play in the water. This exposure would be limited to short times during the summer months. It is assumed that adults and children would have their hands, arms, feet, and legs exposed to surface water, resulting in a skin surface area of 5,672 $cm^2$ for adults (based on an average between men and women) (EPA 2004) and 4,150 $cm^2$ for children (EPA 2008b). It is assumed the duration of each event would not exceed 1 hour.

#### 6.2.3.5 Intake Rates

The consumption rate is the amount of an environmental exposure medium (e.g., soil, air, surface water, or food) ingested or inhaled over a period of time or per event. Default consumption rates of soil, water, and food are provided by the EPA (1989, 1997a, and 2000b) and ADEC (2011) for use in assessing each exposure pathway for adults and children. Intake rates for soil, groundwater and surface water, and food are provided in this subsection.

##### Soil Intake Rate

People are assumed to have contact with COPCs through the incidental ingestion of soil. The soil ingestion rate represents the amount of outdoor soil and indoor dust ingested through hand-to-mouth contact. The ADEC (2011) recommends an incidental soil ingestion rate of 100 milligrams per day (mg/day) for adults and 200 mg/day for children. These values are conservative and slightly higher than the EPA values of 100 mg/day for children (soil and dust ingestion) (EPA 2011a) and 50 mg/day for adults (EPA 1997a). The ADEC's (2011) recommendation for outdoor workers is 100 mg/day, consistent with EPA recommendations (EPA 2002b). The ADEC values were used for all scenarios.

##### Groundwater and Surface Water Intake Rate

People may have contact with COPCs through the ingestion of groundwater or surface water used as a drinking water source. Under the residential scenario, people may use groundwater as the primary drinking water source. The recommended drinking water ingestion rate for an adult resident is 2 liters per day (ADEC 2011) and for a child resident is 1 liter per day (EPA 2008b). It is also assumed that groundwater would be used for drinking water in an industrial setting while people are working at the site. ADEC (2011) recommends an ingestion rate of 2 liters per day under this scenario, as well.

Surface water ingestion rates for adults and children are consistent with the drinking water ingestion rates used for groundwater exposure. These rates were determined to be conservative and based on the assumption that surface water would be used as the primary drinking water while at the RDM site during recreational or subsistence activities.

### Food Intake Rate

Plants harvested within the assessment area may take up COPCs from soil into their leaves and roots. In addition, wildlife may take up COPCs through ingestion of soil and consumption of local vegetation and animals. People who consume local vegetation and wildlife, therefore, may indirectly take up COPCs from the RDM site. Human intake of COPCs through food ingestion is determined by the types of food ingested, the amount of each type of food ingested per day, the concentration of COPCs in the food, and the percentage of the diet constituting food within the assessment area.

To develop the appropriate wild food intake rates for use in the HHRA, representatives from E & E met with representatives from the EPA, ADEC, BLM, Alaska Department of Health and Social Services, and the Agency for Toxic Substances and Disease Registry on February 14, 2012, and February 23, 2012, to discuss incorporation of the results from the ADF&G report, summarized in the *Proposed Approach to Evaluating Consumption of Wild Foods at the Red Devil Mine Site, Alaska, Version 2* (E & E 2012), into the HHRA. Development of wild food intake rates for use in the HHRA is discussed further below.

### Available Harvest and Consumption Data, Prior to 2012

Previously, there was limited subsistence harvest or consumption data available for the Red Devil area. Although harvest data can provide information on site use patterns, it does not often provide quantitative evaluation of consumption patterns. The following discussion presents harvest and/or consumption reports that are available and relevant to the site.

The ADEC recommends that wild food ingestion rates be obtained from the ADF&G Community Profile Database (ADEC 2011), now incorporated in the Community Subsistence Information System (CSIS). Big game data from the Central Kuskokwim Big Game Survey for 2003, 2004, and 2005 are available for Red Devil in the CSIS (ADF&G 2011). The CSIS was also queried for harvest data for the neighboring communities of Sleetmute, Crooked Creek, and Stony River. Only big game data from the Central Kuskokwim Big Game Surveys of 2003, 2004, and 2005 are available for Crooked Creek and Stony River. For Sleetmute, in addition to the large game data, harvest data for other wild food resources are available in the CSIS; however, the data are from 1983, prior to use of the consumption adjustments for use in risk assessments, as described by Wolfe and Utermohle (2000).

ADF&G conducted household interviews in Red Devil in 1986 to determine resource use patterns (Brelsford et al. 1987). Although this report provides information on some harvest patterns, it does not provide sufficient detail to determine quantitative ingestion rates, and it is more than 20 years old.

Ballew et al. (2004) conducted a 12-month recall consumption survey in 13 villages throughout Alaska. The regional health corporation serving the village of Red Devil is the Yukon–Kuskokwim Health Corporation (YKHC) (Alaska Community Database 2010). Four villages from the YKHC region are represented in the Ballew et al. report, although the names of the specific villages are not provided. The following subsistence foods were identified in the top 50 foods reported to be consumed in greatest quantities by the participants in the YKHC region:

- King salmon
- Moose muscle and organs
- Chum salmon
- Caribou muscle and organs
- Whitefish
- Silver salmon
- Crowberries
- Lowbush salmonberries
- Moose fat and marrow
- Pike
- Seal oil
- Herring
- Tomcod
- Caribou fat and marrow
- Blackfish
- Blueberries
- Goose

For each of the subsistence foods, information is provided on the median and maximum amounts (in pounds per year) consumed in that region. These values are presented in Table 6-20, as adjusted to grams per day based year-round consumption (i.e., ED = 365 days per year), and broken up into major wild food source categories. The harvest rates were calculated by summing all food into the major categories of salmon, non-salmon fish, large land mammal, berries, and birds.

IDM Consulting (1997) was contracted by the ADEC to evaluate existing subsistence information in an effort to define subsistence regions and develop subsistence consumption parameter distributions for use in human health risk assessment. IDM (1997) concluded that, although harvest data significantly overestimate consumption for some resources, in the absence of more extensive consumption data, harvest data may be reasonably used as a surrogate for preliminary estimation of consumption (IDM 1997). IDM (1997) provides harvest rates for the following major resource categories: salmon, non-salmon fish, large land mammals, marine mammals, and marine invertebrates. Harvest rates are provided on per capita, $50^{th}$ percentile, $90^{th}$ percentile, $95^{th}$ percentile, and maximum levels. The $50^{th}$ and $95^{th}$ percentiles are provided in Table 6-20 for the Subarctic Interior region which includes Red Devil Village. Marine mammals and marine invertebrates harvest rates are not included in Table 6-20 due to the lack of these categories listed as subsistence foods by Ballew et al. (2004), the large distance to a marine mammal or invertebrate harvest area from the site, and the low harvest levels for marine mammals and invertebrates (IDM 1997).

Harvest rate data from Ballew et al. (2004) and IDM (1997) are summarized in Table 6-20. For comparison, ingestion rates recommended by the EPA's Exposure Factors Handbook (2011) also are included. The berry values represent mean ingestion rates, body weight adjusted for adults, for the Native American consumers (EPA 2011, Table 9-17).

A number of Native American fish intake rates are summarized in the Exposure Factors Handbook (EPA 2011). Of those studies, one conducted in Alaska (Wolfe and Walker 1987) and two conducted in Washington (Toy et al. 1996; Duncan 2000) were chosen as the most representative for the Red Devil Mine site. In addition, Toy et al. (1996) and Duncan (2000) were recommended for review by EPA Region 10's Lon Kissinger (Kissinger 2011). These ingestion rates are provided in Table 6-21. For comparison, the IDM (1997) fish ingestion rates are also provided in Table 6-21.

### Alaska Department of Fish and Game Harvest Report, 2012

Between January and December 2010, residents of Aniak, Chuathbaluk, Crooked Creek Lower, Kalskag, Red Devil, Sleetmute, Stony River, and Upper Kalskag were surveyed regarding the subsistence and harvest use of wild foods in those communities. The principal questions addressed were how many wild foods were harvested for subsistence, the harvest amounts, and how these foods were distributed within and between communities (Brown et al. 2012).

The survey represents a 12-month recall study, covering 2009, used to estimate subsistence harvests and uses of wild fish, game, and plant resources. Information was obtained on a household basis. The survey questions are provided in the ADF&G report (Brown et al. 2012). Maps of the area used for hunting, fishing, and gathering during the study year were developed.

The population trend in Red Devil has decreased since the census count in the 1960's. During the study, the estimated population of Red Devil was 32 residents. Eleven households in Red Devil were surveyed, which included 27 residents. On average, residents lived in Red Devil approximately 23 years. The surveyed population was 44 % female and 56 % male. Eighty-two percent were Alaska Native.

Of the households surveyed, 100 % used some kind of wild food, and 82 % reported that they harvested wild food. Of the top 10 resources making up the majority of the wild foods harvested by edible weight, salmon species contributed 40 %, whitefish species contributed 27 %, other non-salmon fish species contributed 11 %, black bears contributed 5 %, and beaver contributed 3 % of the total subsistence harvest. Estimated uses and harvest rates of wild foods are provided in Tables 7-1 through 7-6 of the ADF&G report (Brown et al. 2012). These tables present the percentage of households that use, attempt to harvest, harvest, receive, or give away each resource. Estimates of pounds harvested are provided as a total for the community, mean per household, mean per capita, and total estimated amount of harvest by the community.

Per ADEC (2011), high end user rates from ADF&G should be used to estimate ingestion rates for specific resources. The high end user is represented by the 95$^{th}$ percentile per capita use, which is the amount of wild food used by the consumer at the 95$^{th}$ percentile rank in a rural population during a survey year, expressed as a per person measure of grams per day (Wolfe and Utermohle 2000). This is the value recommended for use in an HHRA.

The 95$^{th}$ percentile use is determined by:

1. Allocating household harvests of a resource category among three households;
2. Grouping based on reported use and sharing patterns during a survey year;
3. Summing a household's use levels across resource categories;
4. Ranking households by quantities used; and
5. Identifying the use level of the consumer at the 95$^{th}$ percentile rank.

The 95$^{th}$ percentile use value was calculated by ADF&G consistent with the methodology outlined in Wolfe and Utermohle (2000) and provided to the BLM (Koster 2012).

### Potential Suppression Effect

A "suppression effect" occurs when a consumption rate for a given population reflects a current level of consumption that is artificially diminished from an appropriate baseline level of consumption for that population (National Environmental Justice Advisory Committee 2002). Although a suppression effect has primarily been studied in the context of fish harvests, discussion of this effect has been expanded to include all wild food harvest. A suppression effect can be caused by a number of factors, including situations when an environment has become contaminated to the point that humans refrain from harvesting from a particular area. A suppression effect also may arise when wild foods upon which humans rely are no longer available in historical quantities (and kinds), such that humans are unable to catch and consume as much wild food as they previously had or otherwise would.

Harvest data from nearby areas were reviewed to determine if a suppression effect was occurring in the Red Devil area, as compared to other nearby communities. Family relationships exist between current residents of Red Devil and Sleetmute who once lived along the Holitna River (Brown et al. 2012); therefore, Sleetmute was included for comparison. Due to geographical location, Crooked Creek and Stony River were also included for comparison. Harvest rates, on a mean per capita basis, were evaluated for the primary harvest categories identified by Red Devil households.

For the categories of birds and non-salmon fish, Red Devil households showed the highest harvest rate, on a per capita basis, compared to Sleetmute, Stony River, or Crooked Creek. Red Devil harvest rates for plants and berries were 8 pounds per year, close to the highest rate of 8.7 pounds per year in Crooked Creek. For small land mammals, the Red Devil harvest rates were low compared to Stony River but comparable to Sleetmute and Crooked Creek. For these resources, no suppression effect is evident when compared to harvest rates in neighboring communities. Therefore, the harvest rates for Red Devil for these resources are appropriate estimates of consumption for use in the HHRA.

For large land mammals, black bears contributed the largest harvest amount, followed by beavers and caribou. Reports from interviews conducted in 2010 concluded that severe declines in the availability of moose in the region have led to an increase in the harvest and use of black bears by village residents. While limited by the lack of historical data, a rise in black bear uses and harvests by Red Devil households may indicate an adaption to declines in the availability of other large game resources, such as moose and caribou. Several respondents reported during the harvest survey that, prior to the moose hunting closure in Game Management Unit 19A, moose were the primary subsistence resource for the village. While caribou were never heavily harvested by the Red Devil community, a reported decline in caribou harvests is, in part, explained by both a lack of hunting activity in traditional areas, where caribou have most often been found, and the general migration of the Mulchatna caribou herd away from the region (Brown et al. 2012).

Large game mammal harvest data is available for Red Devil from 2003, 2004, 2005 (ADF&G 2011) and the ADF&G 2012 report (harvest data from 2009). In 2006, following at least a decade of severe moose declines in Game Management Unit 19A, the majority of the game management unit, including the Holitna and Hoholitna river drainages, was closed to moose hunting, and the remainder was limited to hunt opportunities requiring Tier II permits. In 2003, Red Devil residents harvested an estimated 36 pounds of moose per person. However, zero moose harvests were reported in 2004, 2005, and 2009. Similar declines were shown for caribou, with black bear harvests increasing (Brown et al. 2012). Based on this, it appears that the moose harvest rates from 2003 would represent the harvest not impacted by a suppression effect.

### Intake of Wild Food Exposure Parameters

Based on the discussion above, harvest rates from Red Devil for 2009 (Brown et al. 2012) represent the most appropriate estimates of consumption for most resource categories and are recommended for use in the HHRA, with the exception of large land mammals. Harvest rates for large land mammals were derived from the 2003 ADF&G survey results to account for potential suppression of harvest of these resources due to hunting restrictions or resource availability. Although harvest data significantly overestimate consumption for some resources (IDM 1997) and the data were obtained on a household rather than individual basis, these harvest rates are the most applicable, site-specific values available and allow for a health-protective approach for evaluating risk from consumption of subsistence resources.

Harvest rates for adults were calculated as the sum of all use rates for food within specified food categories. Because harvest rates are provided on an annual basis, the EF for wild foods is equal to a full year, 365 days per year. Harvest rates for the resident, subsistence/recreational user, and mine worker receptors are equal with differing FIs. The specified food categories used to calculate the harvest rates are:

1. Non-salmon fish
2. Large land mammals
3. Small land mammals
4. Birds and eggs
5. Berries and plants

For each category, a representative species was chosen as the indicator for the category. For example, Red Devil households indicated that they harvested the ollowing berries and plants for consumption in 2009:

- Blueberry
- Lowbush cranberry
- Crowberry (blackberry)
- Wild rhubarb
- Hudson’s Bay tea
- Stinkweed

The harvest rate for the berries and plants category is set at the 95$^{th}$ percentile use rate for all six resources. The indicator species for the category was chosen as blueberries, based on the high harvest rate compared to other resources, as well as the availability of contaminant level data. Table 6-22 shows the food source categories, indicator species, study, and statistics that are used for the estimation of ingestion or consumption rate.

The harvest data were collected on a household basis, and not for the individuals within the community. At the time of the survey, the age of people from households surveyed ranged from 10 to 90 years of age, with an average age of 41 years old. Therefore, the values obtained from the survey are representative of an adult exposure scenario. No child rates were available.

A ratio of children to adult estimated energy requirements (EER) is used to develop estimates of children’s consumption of subsistence resources from adult consumption data based on the approach presented in "Dietary Reference Intakes for Energy, Carbohydrates, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids" (NAS 2002). This approach assumes that caloric intake and energy requirements are directly related to each other.

For children, the EER includes both total energy expenditure in kilocalories per day (TEE) plus energy required for growth and development. For young children, ages 0 through 2 years, physical activity levels are generally similar and gender differences were not observed. The equation used to develop EERs for young children is:

$$EER = TEE + \text{energy deposition}$$

This equation was used for children aged 0 through 35 months. EERs for boys and girls with "active" physical activity levels for the age ranges of 3–4 years, 4–5 years, and 5–6 years were obtained from Tables 5-20 and 5-21 in Institute of Medicine of the National Academies (2002). The EERs for each of these age ranges were averaged across genders. The time period associated with each EER was used to develop a time weighted average (TWA).

A similar analysis was done for individuals aged 6 through 70 using Tables 5-20, 5-21, and 5-22 in the Institute of Medicine of the National Academies (2002). For the adult EER analysis, data were used from the physical activity class of "active" and a body mass index (BMI) of 24.99 kilograms per square meter. This BMI is somewhat below the average BMI for Americans, but it was the highest BMI for which EERs were available in NAS 2002. For each age class, EERs were averaged across genders.

The ratio of the TWA EERs for children to adults was 0.48.

For this assessment, the adult consumption rates are multiplied by 0.48 to produce estimates of children's consumption. This value is similar the value derived from the Columbia River Inter-Tribal Fish Commission (1994) study based on a ratio of child to adult consumption rates for fish of 0.4.

As requested by the ADEC, health protective estimates of risk are calculated based on an FI=1 (all food consumed is harvested from the site) for the residential scenario. This value is very conservative, based on the harvest areas identified in the ADF&G report (Brown et al. 2012). Additional FI values for the residential scenario are discussed below and are consistent with the FIs for the recreation/subsistence user.

Recreational visitors and subsistence users would visit the site a portion of the year during harvest time and presumably would camp in the area. If the RDM site is redeveloped in the future as a mine, it is assumed that industrial or mine workers would work at the site and live in nearby Red Devil. It is assumed that these receptors (recreational/subsistence user and mine worker) would also harvest in other areas outside of the Red Devil Mine site.

Based on discussions with the ADEC and EPA, the FI for recreational visitors/subsistence users and mine workers is calculated based on a ratio of the area of the RDM site to the total harvest area for the food source category of interest. Harvest maps for trout and whitefish, large land mammals, small land mammals, ducks and geese, and berries and greens are available from the 2009 survey (Brown et al. 2012). This approach assumes that the fraction of the food harvested is based on harvest area. The total site area is approximately 246 acres.

For large land mammals, small land mammals, and berries and greens, the FI was calculated using the following equation:

$$FI = \frac{Area\ of\ site\ (acres)}{Area\ of\ harvest\ locations\ for\ wild\ food\ (acres)}$$

For fish and birds, harvest locations were identified during the 2009 survey. For these resources, the FI was calculated based on number of harvest locations. For instance, five harvesting locations were identified for trout and whitefish, including an area near the site. Therefore, the FI was set at 0.2 (20 %) based on one location near the RDM divided by five total harvesting locations. For birds, two harvest locations were reported in the ADF&G report (Brown et al. 2012) although no harvest locations were identified near the RDM. It is assumed that if grouse or other birds were available near the RDM, they would be harvested in that area. Therefore, the FI was set at 0.33 (33 percent) based on one harvest location divided by three total harvesting locations (two reported in the ADF&G report and one near the RDM, not reported during survey).

For many resources, the RDM site is not within the harvest areas identified by ADF&G (no wild food harvested within the mine area); therefore, the respective FIs are health-protective by assuming that the mine area is within the harvest area.

Proposed exposure parameters for the FI and exposure frequency to subsistence resources are provided in Table 6-19.

#### 6.2.3.6 Arsenic Bioavailability

Using total soil arsenic concentrations to quantify daily chemical intake typically results in estimated carcinogenic risk results greater than $10^{-6}$ for soils in naturally occurring background settings (Rodriguez et al. 2003).

These estimated cancer risk results are skewed high because the amount of arsenic that can be extracted from soil in the laboratory is greater than the amount that actually would be taken up by an organism. One method of reducing uncertainty and obtaining more reasonable risk estimates is to quantify that amount of arsenic in soils that is bioavailable. Bioavailability is a measure of the fraction of a contaminant that is absorbed by an organism via a specific exposure route.

The bioavailability of absorbed inorganic arsenic depends on the matrix in which it is contained. Arsenic taken into the body through drinking water is in a water-soluble form, and it is generally assumed that its absorption from the gastrointestinal tract is nearly complete. Arsenic in soils, however, may be incompletely absorbed because some of the arsenic may be present in water-insoluble forms or may interact with other constituents in the soil.

EPA Region 10 recommends use of 60 percent relative bioavailability of total arsenic if contamination is primarily a result of impacts by the mineral industry activities of extraction or beneficiation such as mining, milling, tailings disposal, and other similar activities, and if there are also no associated smelting activities (EPA 2000d). The default value of 60 percent was obtained from the EPA Region 10 animal study (EPA 1996c). EPA Region 10 indicates there is a high level of uncertainty associated with this default assumption of relative bioavailability because there are no acceptable *in vivo* studies comparing the uptake of arsenic in these matrices with the uptake of soluble arsenic from orally ingested water, and therefore, there are no quantitative data from which to develop a default value (EPA 2000d).

For soil ingestion and dust inhalation exposures, soil intakes are multiplied by the default relative bioavailability of 60 percent to estimate the level of arsenic that reaches systemic circulation.

Site-specific arsenic *in vitro* bioaccessibility was also measured in 14 surface soil samples, as an estimate of bioavailability of arsenic at the site. Results from soil samples are presented Table 6-23 and discussed in further detail in Section 5.3. Arsenic bioaccessibility samples were collected from seven of the soil types introduced in Section 3.1.3. Samples were sieved to less than 250 micrometers for use in the HHRA.

Arsenic bioaccessibility results ranged from 2.7 percent in the MPA to 68.1 percent in background soil samples. No strong correlation between total arsenic concentrations and arsenic bioaccessibility was found. Arsenic bioaccessibility in the two background samples showed the highest percent bioaccessibility ranging from 34.9 to 68.1 percent. There was one sample collected from the DA exposure unit with a result of 36.1 percent. The MPA results ranged from 2.7 to 47.3 percent. The SMA results ranged from 4 to 43 percent. Based on these results, the default value of 60 percent is a conservative, health-protective estimate of true bioavailability at the site.

#### 6.2.3.7 Estimation of Contaminants of Potential Concern Concentrations in Media

As discussed above, concentrations of COPCs to which human receptors would potentially be exposed to over time were estimated per EPA guidance (EPA 1992) using the 95-percent UCL as the EPC for soil, sediment, surface water, and groundwater. Maximum concentrations in groundwater were also evaluated.

Estimated media concentrations are used for exposure pathway calculations and estimating COPC concentrations in wild food. Uptake of COPCs from various media by plants and animals may cause exposures to ecological receptors and humans who consume local plants and animal products. The following subsections describe how COPC concentrations were obtained for food items such as berries, plants, game, and fish. Determination of concentrations of COPCs in air is also discussed in this section.

### Contaminants of Potential Concern Concentrations in Fish

In 2010, the BLM conducted a study of Kuskokwim River, Red Devil Creek, and other tributaries to the Kuskokwim River near the RDM site. Forage fish (e.g., slimy sculpin) were collected and analyzed for site-related chemicals. It is assumed that people may be catching and consuming game fish from the Kuskokwim River near the mouth of Red Devil Creek and potentially, to a lesser extent, in Red Devil Creek, that may be impacted from COPCs from the site.

BLM sculpin fish tissue data from Red Devil Creek is used to estimate concentrations of chemicals in game fish using a food chain multiplier (FCM) approach. The concentration of COPCs in game fish is estimated from the slimy sculpin concentration from Red Devil Creek multiplied by an FCM. For methylmercury, an FCM of three is assumed to account for biomagnification (i.e., the game fish concentration of methylmercury is set equal to three times the concentration in sculpin). This approach is supported by the fact that the biomagnification of methylmercury typically is three-fold with each trophic transfer (McGeer et al. 2004). For inorganic mercury and other metals, an FCM of one is assumed. This approach is defensible because biomagnification of metals (other than methylmercury) in aquatic organisms is rare. In fact, an inverse relationship has been shown for the trophic transfer of metals (except methylmercury) via the diet—that is, concentrations decrease from one trophic level to the next (McGeer et al. 2004). Hence, use of an FCM of one for inorganic mercury and other metals is conservative.

Based on the ADF&G report (Brown et al. 2012), non-salmon game fish ingested by residents of Red Devil include Dolly Varden, sheefish, round whitefish, whitefish (other), burbot, grayling, and Northern pike. The trophic levels for slimy sculpin and the game fish of interest are provided below (FishBase Consortium 2011):

- Slimy scuplin – 3.37
- Dolly Varden – 4.23
- Sheefish – 4.15
- Round whitefish – 4.03
- Burbot – 4.03
- Grayling – 3.1
- Northern pike – 4.4

Based on these data, it was conservatively assumed that the game fish of interest are one trophic level above the slimy scuplin, except for grayling, which feed at a slightly lower trophic level than scuplin. Using the sculpin data to estimate game fish concentrations in the Kuskokwim River is a health-protective approach because sculpin are more resident than the fish taken from the Kuskokwim River. This approach likely overestimates the true concentrations of fish that people are catching and consuming from the Kuskokwim River.

Slimy sculpin data for Red Devil Creek from the BLM June and August 2010 sampling events are presented in Table 6-9. The EPCs for COPCs in slimy sculpin are provided in Table 6-15. As discussed in Section 6.2.4.2, to estimate the inorganic arsenic concentration in fish tissue, the total arsenic EPC in sculpin was multiplied by 10 percent to determine the inorganic arsenic fraction used to characterize risks and hazards. In December 2011, the BLM analyzed fish tissue for inorganic arsenic. Those data are not yet available for use in the draft HHRA but will be incorporated into the final HHRA if they become available.

The BLM harvested 17 northern pike, 11 burbot, two sheefish, and one humpack whitefish from the Kuskokwim River in the reach near Red Devil Creek, Reach C. Northern pike samples had the highest sample number and represent a high harvest rate compared to other game fish; therefore, northern pike was used for comparison to the game fish modeled results. Table 6-24 shows the modeled concentrations of arsenic, antimony, and mercury compared to the results from Reach C of the Kuskokwim River for Northern Pike muscle and liver tissue.

As shown in Table 6-24, the concentrations of antimony, arsenic, and mercury of game fish modeled from the sculpin from Red Devil Creek greatly exceed the measured concentrations in northern pike collected from the reach of the Kuskokwim River nearest to the RDM. Impacts of using the modeled concentrations of COPCs in game fish versus the game fish collected from the Kuskokwim River are discussed in Section 6.2.6.2.

#### Contaminants of Potential Concern Concentrations in Large Land Mammals

No data on levels of site-related chemicals in wild game are available for the RDM site. According to ADF&G (Brown et al. 2012; ADF&G 2011), people in Red Devil harvest and consume black bear, moose, and caribou. In lieu of actual measured concentrations, metal concentrations in beef cattle, adjusted for moose, are estimated from metal concentrations in moose diet. This is based on the approach developed by Baes et al. (1984) and recommended by the EPA (2007j, 2005l). The general equation is:

$$C_M = F_f \times 27 \times C_D$$

Where:

- $C_M$ = Metal concentration in moose tissue (mg/kg dry)
- $F_f$ = Ingestion-to-beef transfer coefficient (days/kg) (from Baes et al. 1984)

27 = Constant; moose consume 27 kg/day of feed
$C_D$ = Diet metal concentration (mg/kg dry) based on plant sample results collected in 2011

During the fall and winter, moose consume large quantities of willow, birch, and aspen twigs; during the summer, moose feed on forbs, vegetation in shallow ponds, and the leaves of birch, willow, and aspen (ADF&G 2012a, 2012b). Moose forage rates were estimated by Moen et al. (1997) as an average of 10.5 kg dry mass per day, with a range of 9.45 to 11.55 kg dry mass per day. In the fall, a moose can eat about 50–60 pounds (22–27 kg) of food per day (The Wilderness Classroom Organization 2002). The equation above was adjusted to incorporate moose forage rate, or consumption of feed, at a rate of 27 kg per day, a high-end health-protective estimate of year-round consumption. This approach is used to estimate the concentrations in moose, an indicator species for large land mammals.

The metal concentration in moose diet is obtained from results from the green alder bark samples. The green alder bark samples that were collected in 2011 represent the best surrogate for metals levels in alder twigs, leaves, and buds. Metal concentrations in the moose diet from the green alder bark samples were estimated using the FCM approach described above for fish (FCM = 3 for methylmercury and 1 for all other metals), although no methylmercury was detected in the green alder bark samples. EPCs for COPCs in green alder bark are presented in Table 6-16.

### Contaminants of Potential Concern Concentrations in Small Land Mammals and Birds

Based on the ADF&G report (Brown et al. 2012), within Red Devil people harvest and consume beaver, snowshoe hare, river otter, mink, muskrat, and porcupine. Beaver is consumed at the highest rate and is used as an indicator for this resource category. Metal concentrations in small mammals were estimated from concentrations in their diet using the FCM approach described for fish (FCM = 3 for methylmercury and 1 for all other metals). Green alder bark from the site was sampled and analyzed for metals in 2011. These data are used to represent the beaver diet, and the EPCs are presented in Table 6-16.

Based on the ADF&G report (Brown et al. 2012), within Red Devil people harvest and consume primarily spruce grouse and ruffed grouse. White spruce needles from the site were sampled and analyzed for metals in 2011. These data are used to represent the spruce grouse diet. Metals concentrations in spruce grouse muscle were estimated from the concentration in their diet using the FCM approach described for fish (FCM = 3 for methylmercury and 1 for all other metals), although no methylmercury was detected in the white spruce needle samples. EPCs for COPCs in white spruce needles are presented in Table 6-17.

### COPC Concentrations in Native Vegetation

Based on the ADF&G report (Brown et al. 2012), people in Red Devil harvest and consume blueberries, lowbush cranberries, crowberries (blackberries), wild rhubarb, Hudson's Bay tea, and stinkweed. Based on the amount consumed and the availability of limited concentration data, blueberry fruit is used to represent this wild food category.

Chemical concentrations in blueberry fruit is modeled based on the following uptake equations from Baes et al. (1984):

$$Cv = Cs \times Br$$

Where,
Cv = Concentration in non-vegetative (reproductive) portion of food
Cs = Concentration in soil (mg/kg)
Br = Soil-to-plant elemental transfer coefficient for non-vegetative (reproductive) portions of food crops

The transfer coefficient for reproductive portions of plants is obtained from Figure 2-2 of Baes et al. (1984).

Total mercury and methylmercury have been measured in several terrestrial plant species from the RDM site, including willow, white spruce, black spruce, and blueberries (Bailey et al. 2002; Bailey and Gray 1997). A summary of the previous plant data is provided in Tables 1-3 and 1-6. Mercury and methylmercury were measured in blueberry fruit near the retort and mined areas of Red Devil Mine (Bailey and Gray 1997). Additional sampling of alder, blueberry, white spruce, and pond plants was conducted in summer 2011, although there were not sufficient blueberry fruit samples available for analysis. As shown in Table 6-25, the modeled mercury concentrations in blueberries are significantly higher, by at least one order of magnitude, than the highest detected mercury concentration found in blueberry fruit, although the soil concentrations are within the same range as those from the Bailey and Gray study (1997). Therefore, the modeled values likely overestimate the true mercury concentration in blueberry fruit. No site data are available on the concentrations of other metals in blueberries.

### Contaminants of Potential Concern Concentrations in Air

To estimate the concentration of particulates in dust at the RDM site, EC for particulates is calculated using a particulate emission factor (PEF). The PEF relates the concentration of contaminant in soil to the concentration of dust particles in the air generated from a "fugitive" or open source. PEFs for the residential and worker scenarios are calculated using the equations and parameters identified in the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA 2002b).

Specifically, the PEF is calculated using the following equation:

$$EF = \frac{Q}{Cw} \times \frac{3{,}600}{0.036 \times (1 - V) \times \left({Um}/{Ut}\right)^3 \times F(x)}$$

Where:

PEF = particulate emission factor (cubic meters per kilogram [$m^3$/kg)
Q/C = inverse of mean concentration at center of a 0.5-acre-square source wind (grams per square meter per second, per kilograms per cubic meter [$g/m^2$-s per $kg/m^3$])
V = fraction of vegetative cover (unitless), 0.5 (50 percent)
Um = mean annual windspeed (meters per second [m/s]), 4.69 m/s
Ut = equivalent threshold value of wind speed at 7m (m/s), 11.32 m/s
F(x) = function dependent on Um/Ut, 0.194

The term Q/C is set equal to the value for Minneapolis, Minnesota for the largest source area 46.92 $g/m^2$-s per $kg/m^3$. Consistent with the ADEC's Cleanup Level Guidance (2008d), Minneapolis was used to represent the under 40-inch climate zone. The calculated site-specific PEF is $6.8 \times 10^8$ $m^3$/kg.

The airborne dust concentrations during ATV use for the recreational and subsistence users are estimated using equation E-18 of the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (EPA 2002b). This equation is designed to calculate a PEF associated with construction traffic over unpaved roads but was modified to reflect ATV usage of an unpaved road or trail. The equations and input parameters are provided in Appendix D, Table D-17. The calculated site-specific PEF for ATV use is $3.1 \times 10^9$ $m^3$/kg.

Mercury, in the elemental form, is the only volatile COPC identified in soil or groundwater. To estimate the concentration of volatile compounds in the air from soil at the RDM site, the air concentration was determined based on the soil concentration and the volatilization factor using the equation from EPA (1996a). Default soil parameter values were obtained from ADEC (2008d), and chemical-specific values were obtained from EPA (2011). The value for Q/C was calculated using the equation described above. The resulting volatizing factor for elemental mercury is $2.23 \times 10^4$ $m^3$/kg. Total mercury results were used as the EPC for elemental mercury. Elemental mercury, the volatile form of mercury, can be estimated to be much lower based on the SSE results for $Hg^0$ reported in the F0 and F4 steps of the SEE results, see Section 5.2.2.

The concentration of elemental mercury in air from household uses of groundwater was calculated by multiplying the concentration in groundwater by the default volatilization factor for water of 0.5 liters per cubic meter consistent with the EPA's RAGS Part B (1991). As with soil, the total mercury results were used as the EPC for elemental mercury. Elemental mercury can be estimated to be much lower.

## 6.2.4 Toxicity Assessment

The objectives of the toxicity assessment are to compile information on the nature of the adverse health effects of COPCs and to provide an estimate of the dose-response relationship for each COPC selected (i.e., determine the relationship between the extent of exposure and the likelihood and/or severity of adverse effects).

For the risk assessment, COPCs are divided into two groups: agents known or suspected to be human carcinogens (carcinogens) and noncarcinogens. As used here, the term "carcinogen" denotes any chemical for which there is sufficient evidence that exposure may result in continuing uncontrolled cell division (cancer) in humans and/or laboratory animals. The risks posed by these two groups are assessed differently because noncarcinogenic chemicals generally exhibit a threshold dose below which no adverse effects occur, whereas for carcinogens, the simplifying assumption has been made that carcinogenic responses are linearly related to dosage even in the unobservable area of the dose-response curve. That is, it is assumed for carcinogens that each incremental increase in dosage produces a proportional incremental increase in the risk for cancer.

### 6.2.4.1 Quantitative Indices of Toxicity

The EPA consensus toxicity indices (e.g., chronic reference doses [RfDs] and carcinogenic slope factors [SFs]) were used in the assessment. Toxicity values were obtained using the following hierarchy (EPA 2003a; ADEC 2011) and are consistent with the toxicity values provided in the EPA's Regional Screening Level tables (2011b):

- The Integrated Risk Information System (EPA 2010a) and cited references.
- The Provisional Peer Reviewed Toxicity Values (EPA 2010b) and cited references developed for the EPA Office of Solid Waste and Emergency Response Office of Superfund Remediation and Technology Innovation programs.
- The Agency for Toxic Substances and Disease Registry Minimal Risk Levels (addressing non-cancer effects only).
- The EPA Superfund Health Effects Assessment Summary Tables (EPA 1997b) database and cited references.
- Other criteria as needed.

Noncarcinogenic and carcinogenic indices are tabulated separately.

### Assessment Non-carcinogens

To evaluate noncarcinogenic effects, the EPA (1989) defines acceptable exposure levels as those to which the human population, including sensitive subgroups, may be exposed without adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety. The potential for adverse health effects associated with noncarcinogens (for example, organ damage, immunological effects, birth defects, and skin irritation) usually is assessed by comparing the estimated average daily intake (that is, exposure dose) to an RfD for oral exposure and to a reference concentration (RfC) for inhalation exposure.

RfDs are expressed in units of mg/kg-day, and RfCs are expressed in milligrams per cubic meter ($mg/m^3$). The RfD or RfC is an estimate (with uncertainty possibly spanning an order of magnitude) of the daily intake to humans (including sensitive subgroups) that should not result in an appreciable risk of deleterious effects. The EPA assigns a qualitative level of confidence (low, medium, or high) to the study used to derive the toxicity value, database, and RfD or RfC. The relative degree of uncertainty associated with the RfDs and the level of confidence that the EPA assigns to the data and the toxicity value are considered when evaluating the quantitative results of the risk assessment.

The EPA (2004) has not developed RfDs for dermal exposure to all chemicals, but it has provided a method for extrapolating dermal RfDs from oral RfDs. If adequate data regarding the gastrointestinal (GI) absorption of a COPC are available, then dermal RfDs may be derived by applying a GI absorbance factor to the oral toxicity value (EPA 2004). For chemicals lacking a GI absorbance value, absorbance is assumed to be 100 percent, and the oral RfDs are used to estimate toxicity via dermal absorption.

Oral and dermal toxicity data, including oral and dermal RfDs and GI absorption factor, are presented in Table 6-26. Inhalation RfCs and target organs are presented in Table 6-27.

### Assessment of Carcinogens

The EPA (2005m) uses a weight-of-evidence (WOE) approach to evaluate the likelihood that a substance is a carcinogen. The EPA uses standard descriptors as part of the hazard narrative to express the conclusion regarding the WOE for carcinogenic hazard potential. The EPA recommends five standard hazard descriptors: “Carcinogenic to Humans,” “Likely to Be Carcinogenic to Humans,” “Suggestive Evidence of Carcinogenic Potential,” “Inadequate Information to Assess Carcinogenic Potential,” and “Not Likely to Be Carcinogenic to Humans.” Under the EPA’s previous (1986a) guidelines for carcinogen risk assessment, the WOE was described by categories A through E. These categories are (A) human carcinogen, (B1 or B2) probable human carcinogen, (C) possible human carcinogen, and (D) not classifiable as a human carcinogen, and (E) not a carcinogen to humans (EPA 1996b).

The toxicity of a chemical at low doses is often estimated from high-dose cancer bioassays. The most versatile forms of low-dose extrapolation are dose-response models that characterize risk as a probability over a range of environmental exposure levels. When a dose-response model is not developed for lower doses, another form of low-dose extrapolation is a safety assessment that characterizes the safety of one lower dose, with no explicit characterization of risks above or below that dose. Although this type of extrapolation may be adequate for evaluation of some decision options, it may not be adequate for other purposes that require a quantitative characterization of risks across a range of doses. At this time, safety assessment is the default approach for tumors that arise through a nonlinear mode of action; however, the EPA continues to explore methods for quantifying dose-response relationships over a range of environmental exposure levels for tumors that arise through a nonlinear mode of action (EPA 2005m). The carcinogenic potency is represented by a COPC's SF for oral exposure and is expressed as risk per milligram per kilogram per day [(mg/kg-day)$^{-1}$]. The carcinogenic potency is represented by a COPC's inhalation unit risk (IUR) for inhalation exposure and is expressed as risk per microgram per cubic meter [(μg/m$^{3}$)$^{-1}$].

The EPA (2004) has not developed SFs for dermal exposure to all chemicals, but it has provided a method for extrapolating dermal SFs from oral SFs. This route-to-route extrapolation has a scientific basis because an absorbed chemical's distribution, metabolism, and elimination patterns are usually similar regardless of exposure route. However, dermal toxicity values are typically based on absorbed dose, whereas oral exposures are usually expressed in terms of administered dose. Consequently, if adequate data on the GI absorption of a COPC are available, then dermal SFs may be derived by applying a GI absorbance factor to the oral toxicity value (EPA 2004). For chemicals lacking a GI absorbance value, absorbance is assumed to be 100 percent, and the oral SF is used to estimate toxicity via dermal absorption.

Table 6-28 includes SFs for oral and dermal exposure, and Table 6-29 includes IUR for inhalation exposure. Mutagen potential, and SF basis or source, are also included in these tables. Note that no COPCs are identified as mutagens.

The EPA's *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA 1993b) indicates that carcinogenic polycyclic araromatic hydrocarbons (PAHs_ include benzo(a)anthracene; benzo(b)fluoranthene; benzo(k)fluoranthene; benzo(a)pyrene; chrysene; dibenzo(a,h,)anthracene; and indeno(1,2,3-cd)pyrene. No carcinogenic polycyclic aromatic hydrocarbons were identified as COPCs at the site.

### 6.2.4.2 Assessment of Arsenic and Mercury

Inorganic arsenic has been implicated as the primary toxic form to both aquatic life and humans. The toxicity data (i.e., reference dose and slope factor) for arsenic is from the inorganic form. Speciation of arsenic was conducted in samples collected in soil, sediment, surface water, and groundwater. Total arsenic analysis was also conducted for these samples. The inorganic arsenic results are used to determine the hazards and risks posed by arsenic at the site.

Approximately 85 to 90 percent of the arsenic found in the edible parts of fish and shellfish is organic arsenic (e.g., arsenobetaine, arsenochloline, dimethylarsinic acid), and approximately 10 percent is inorganic arsenic (EPA 2003c). For the fish tissue results from the BLM study (Matz 2011), total arsenic was measured in the tissue. Inorganic arsenic concentration data in fish tissue is not yet available. To determine the inorganic arsenic in the fish tissue, the total arsenic EPC was multiplied by 10 percent to determine the inorganic arsenic fraction.

Both mercury and methylmercury were identified as COPCs in fish based on sediment and surface water screening. For the fish tissue result from the BLM study (Matz 2011), total mercury results were measured in the tissue. For the current HHRA, mercury in fish was assumed to be 100 percent in the methylmercury form (EPA 1993a).

#### 6.2.4.3 Assessment of Lead

Lead was identified as a COPC in soil, sediment, surface water, and groundwater. Although the toxic effects from lead exposure are well known, there are no verified or consensus toxicity values available for lead in the Integrated Risk Information System, Superfund Health Effects Assessment Summary Tables, or other sources. The absence of authoritative toxicity values reflects the scientific community's inability to agree on a threshold dose for lead's noncarcinogenic effects or to satisfactorily estimate its carcinogenic potency, despite a large body of scientific literature on its toxicological effects.

Due to the lack of toxicity values, exposure to lead is assessed using physiologically based toxicokinetic models for children and adults. The exposure estimates derived using these models are then compared with accepted limits.

Models have been adopted to assess blood lead dose-response relationships in adults and children in lead-contaminated areas. Young children are the segment of the population at greatest risk from lead exposure because, in comparison to adults, their intake of lead from the GI tract is greater (50 percent for children versus 5 percent for adults) and their developing organ systems are more sensitive to the toxic effects of lead. Therefore, the lead Integrated Exposure Uptake Biokinetic (IEUBK) model is recommended (EPA 2007g) to assess potential impacts to children from exposure to lead.

The IEUBK model predicts blood lead levels in young children resulting from multiple pathways of exposure, including intake via air, soil, drinking water, and diet. Default parameters exist in the model for intake of lead via the listed pathways. Site-specific data can also be input into the model to derive site-specific results. For this assessment, the IEUBK Model Win32 v.1.1 was used. All input values used in the model are presented in Appendix E and are discussed in this section. Because lead was identified as a COPC in wild food, adjustments to default input parameters were made based on lead concentrations in locally caught wild food.

The IEUBK dietary intake parameter does include consumption of wild food from local sources as a default parameter; therefore, intake via wild food consumption was included as an “alternate” dietary source of lead. The default daily dietary lead intake values for each age apply to a typical child in the United States. These estimates are derived from U.S. Food and Drug Administration food monitoring data collected 1995–2003 (EPA 2007g). Site-specific data can be used to alter the default dietary intake rates due to the consumption of locally caught food.

Information on lead concentrations in wild food and the proportion of locally caught and consumed wild food to all consumed food is input into the model. The concentration for game from hunting was set at the lead concentration in moose, which represents the highest ingestion rate for game. It is assumed that locally caught fish and meat represent 100 present of all meat consumed. The percentage of fish and meat to total meat was calculated by dividing the fish or game meat (sum of moose, beaver and grouse) by the total meat consumed (sum of game meat plus fish). This approach results in fish representing 70 percent of the total meat consumed and hunted game represented 30 percent of all meat consumed. The percentage of locally harvested berries and plants to all fruit ingested was calculated by dividing the site-specific berries and plant ingestion rate by the body weight, adjusted 95$^{th}$ percentile of all fruit consumed from the EFH (EPA 2011, Table ES-1). These are conservative, health-protective assumptions used in the model.

The IEUBK model has been validated using central tendency input parameters. IEUBK guidance (EPA 2007k) calls for central tendency (i.e., average) inputs and, specifically, arithmetic means should be used for the lead concentration term (EPA 2007d). Therefore, average concentrations of detected values for all wild food sources were used as the EPC. Since lead did not represent a risk to the most sensitive receptor, child residents in the MPA, no further modeling of lead was performed.

### 6.2.5 Risk Characterization

Risk characterization, the final component of the risk assessment process, integrates the findings of the first two components (exposure and toxicity) by quantitative estimation of human health risks. For each scenario evaluated, incremental lifetime cancer probability is estimated for an RME exposure scenario.

#### 6.2.5.1 Assessment of Carcinogens

Any exposure to a carcinogen theoretically entails some finite risk of cancer. However, depending on the potency of a specific carcinogen and the level of exposure, such a risk could be practically negligible.

Scientists have developed several mathematical models to estimate low-dose carcinogenic risks from observed high-dose risks. Consistent with current theories of carcinogenesis, the EPA has selected the linearized multistage model based on prudent public health policy (EPA 1986a). As another conservative measure, the EPA uses the upper 95 percent UCL on the dose-response relationship from animal studies to estimate a low-dose SF. By employing these procedures, the regulatory agencies are likely to overestimate the actual SF for humans.

Using the SF (oral and dermal), excess lifetime cancer risks (ELCR) can be estimated by:

$$ELCR = \sum LADI_i \times SF_i$$

Where:

- $LADI_i$ = Exposure route-specific lifetime average daily intake (mg/kg-day).
- $SF_i$ = Route-specific (oral and dermal) slope factor $(mg/kg\text{-}day)^{-1}$.

Using the IUR (inhalation), the ELCR is determined by multiplying the EC by the IUR (EPA 2009c) as shown below:

$$ELCR = \sum EC_i \times IUR_i$$

Where:

- $EC_i$ = Exposure concentration (micrograms per cubic meter [$\mu g/m^3$]).
- $IUR_i$ = Inhalation unit risk $(\mu g/m^3)^{-1}$.

Assuming risk additivity, the ELCR for the oral, dermal, and inhalation routes of exposure are summed. For carcinogens, the residential and recreational/subsistence user scenarios are calculated as an aggregate of child and adult exposure; the first six years of the ED is determined based on the child intake and the remaining time at an adult intake.

Calculated ELCR are provided in Appendix D, Tables D-1 through D-5, and summarized in Table 6-30, presented as one significant figure. The ADEC has set acceptable target levels at $1 \times 10^{-5}$ for multiple exposure pathways. The EPA allows for a risk range of $10^{-6}$ to $10^{-4}$.

#### 6.2.5.2 Assessment of Noncarcinogens

In accordance with EPA guidelines (1989), an HQ for noncarcinogenic risks is derived for each chemical and exposure route and, based on the assumption of dose additivity, the individual HQs are summed over all contaminants to determine the hazard index (HI).

Risks associated with non-cancer effects (e.g., organ damage, immunological effects, birth defects, and skin irritation) are usually assessed by comparing the estimated average exposure to an acceptable daily dose, RfD or RfC. There are two standard approaches for determining RfDs and RfCs, discussed below.

In one approach, the RfD is selected by identifying the lowest reliable no observed adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) in the scientific literature, then applying an uncertainty factor (usually ranging from 10 to 1,000) to allow for differences between the study conditions and the human exposure situation to which the RfD is to be applied. NOAELs and LOAELs can be derived from either human epidemiological studies or animal studies; however, they are usually based on laboratory experiments on animals in which relatively high doses are used. Consequently, uncertainty or safety factors are applied when deriving RfDs to compensate for data limitations inherent in the underlying experiments and for the lack of precision created by extrapolating from high doses in animals to lower doses in humans.

The second approach for determining RfDs and RfCs entails development of a benchmark dose (BMD). In 1995, the EPA's Risk Assessment Forum published guidance on the BMD approach in the assessment of non-cancer health risk. The BMD approach provides a more quantitative alternative in the dose-response assessment than the NOAEL/LOAEL process for non-cancer health effects (EPA 2000c). The use of BMD methods involves fitting mathematical models to dose-response data and using the different results to select a BMD that is associated with a predetermined benchmark response. As an example, the BMD method was used to derive the oral reference dose for methylmercury (EPA 2001b).

Non-cancer hazards are usually assessed by calculating an HQ, which is the ratio of the estimated exposure to the RfD (oral and dermal), as follows:

$$HQ = \frac{CDIi}{RfDi}$$

Where:

$CDI_i$ = Chronic Daily Intake (mg/kg-day).
$RfD_i$ = Reference Dose (mg/kg-day).

Likewise, inhalation hazard is assessed by comparing the EC to the RfC, as follows:

$$HQ = \frac{ECi}{RfCi}$$

Where:

$EC_i$ = Exposure concentration ($mg/m^3$).
$RfC_i$ = Reference concentration ($mg/m^3$).

The HI calculated for a single mode of action is a measure of how close the estimated exposure comes to the RfD. If the HI is less than 1, adverse effects would not be expected. If the HI is greater than 1, adverse effects are possible, but not certain. ADEC and EPA have set the HI standard at 1.0.

Calculated HIs are provided in Appendix D, Tables D-6 through D-10, and summarized in Table 6-31, presented as two significant figures.

If the HI exceeds 1, major chemical-specific effects identified in the derivation of the RfD by mechanisms of action and target organ can be reviewed. Upon segregation, HIs can be recalculated for specific effects or target organs to further define potential risks. Since a single compound, arsenic, contributed significantly to the HI, the hazards were not segregated by target organ in this assessment.

#### 6.2.5.3 Risk Characterization Results

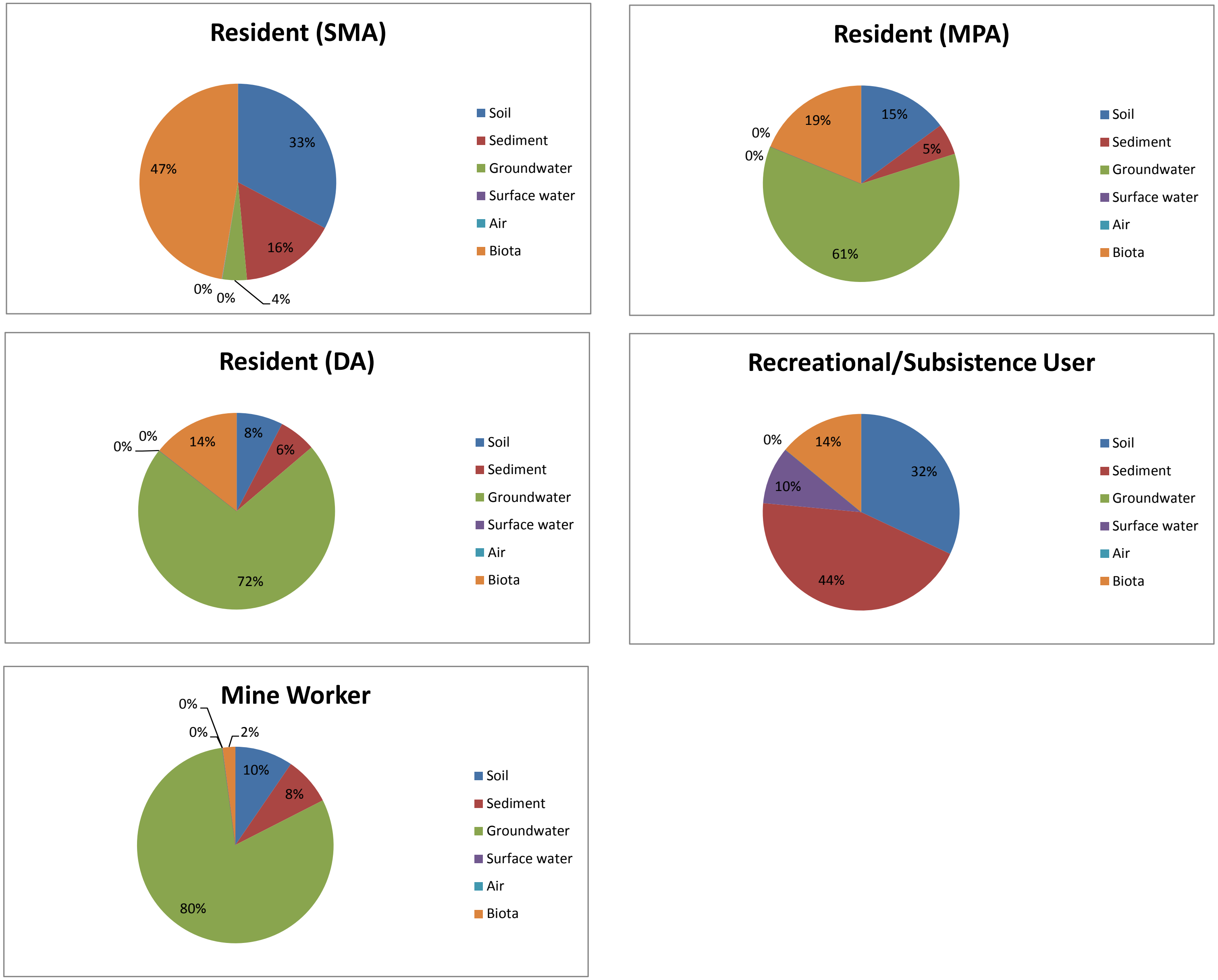
The estimated ELCR values are summarized in Table 6.2-30, and estimated HIs are summarized in Table 6-31. These results are discussed in this this section by potential receptor.

#### Future Resident

Cancer risks and HIs are calculated for a hypothetical future residential that will live and work at the RDM site. Risks and hazards are calculated separately for three different exposure units: SMA, MPA and DA, based on differing COPC concentrations in soil. COPC concentrations in other media sediment, surface water, groundwater, and air remained the same for all three exposure units, except as described below. Note, the air concentrations from fugitive dust or volatilization from soil and the concentration in berries and plants were modeled from soil concentrations, so those concentrations differ between exposure units, as well.

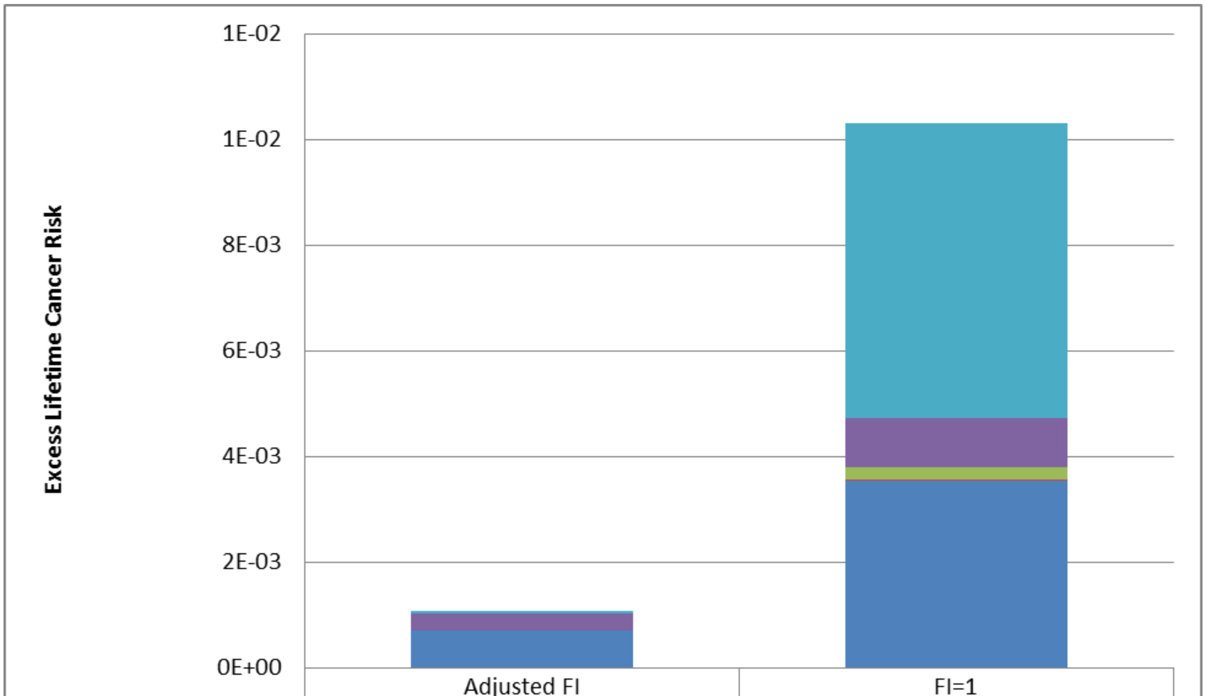
**Surface Mined Area –** The ELCR, including all exposure pathways, for a hypothetical resident in the SMA is 2 x $10^{-2}$ (or 2 in 100), exceeding both ADEC and EPA risk standards of $10^{-5}$ and $10^{-4}$ through $10^{-6}$, respectively. Arsenic is the only carcinogenic COPC onsite contributing to the ELCR. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include biota (47 percent overall risk), soil (33 percent), and sediment (16 percent).

**Figure 6-2. Cancer Risk Contribution by Media, Red Devil Mine**



For the resident, it is conservatively assumed that all wild food consumed was harvested from the site. A more realistic estimate would be to use the FI calculated for the recreational/subsistence user, which is based on data obtained from the ADF&G survey of residents of Red Devil Village (Brown et al. 2012). Using these estimates, biota contributes 9 percent of the overall risk, versus 47 percent. Figure 6-3 shows in the impacts of using these estimates for FI, resulting in lower ELCR from ingestion of biota.

Although ingestion of fish contributes significantly to the overall risk at the site, the concentrations in fish were conservatively modeled from sculpin collected in Red Devil Creek. As discussed in Section 6.2.3.7, the concentrations of antimony, arsenic, and mercury of game fish modeled from the sculpin from Red Devil Creek greatly exceed the concentrations in Northern Pike collected from the reach of the Kuskokwim River nearest to the RDM. The 95 percent UCL of measured arsenic in northern pike muscle is 0.626 mg/kg-wet, compared to the modeled concentration of 11.4 mg/kg. Using the arsenic fish concentrations in northern pike, as shown in Table 6-24, the ELCR from ingestion of game fish is 5 x $10^{-5}$. This evaluation is equal for residents in all exposure units (i.e., fish ingestion is calculated on a site-specific basis and not influenced by the exposure units).




| | Adjusted FI | FI=1 |
|---|---|---|
| Berries and Plants | 6E-05 | 6E-03 |
| Birds | 3E-04 | 9E-04 |
| Small Land Mammals | 5E-06 | 2E-04 |
| Large Land Mammals | 3E-07 | 2E-05 |
| Fish | 7E-04 | 4E-03 |

**Figure 6-3 Impacts of Fraction Ingested from Contaminated Source (FI), Resident Scenario**

The HI, including all exposure pathways, for a hypothetical resident in the SMA is 528 for adults and 1314 for children, exceeding both ADEC and EPA HI criteria of 1.0. Figure 6-4 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child resident. Child HIs are shown since they represented the potentially highest exposed receptor. Ingestion of biota (primarily fish consumption) contributes 94 percent to the overall HI for adults and 85 percent for children. Adjustment of the FI, as described above reduces the HI for ingestion of biota from 495 to 92 for adults and from 1109 to 207 for children.

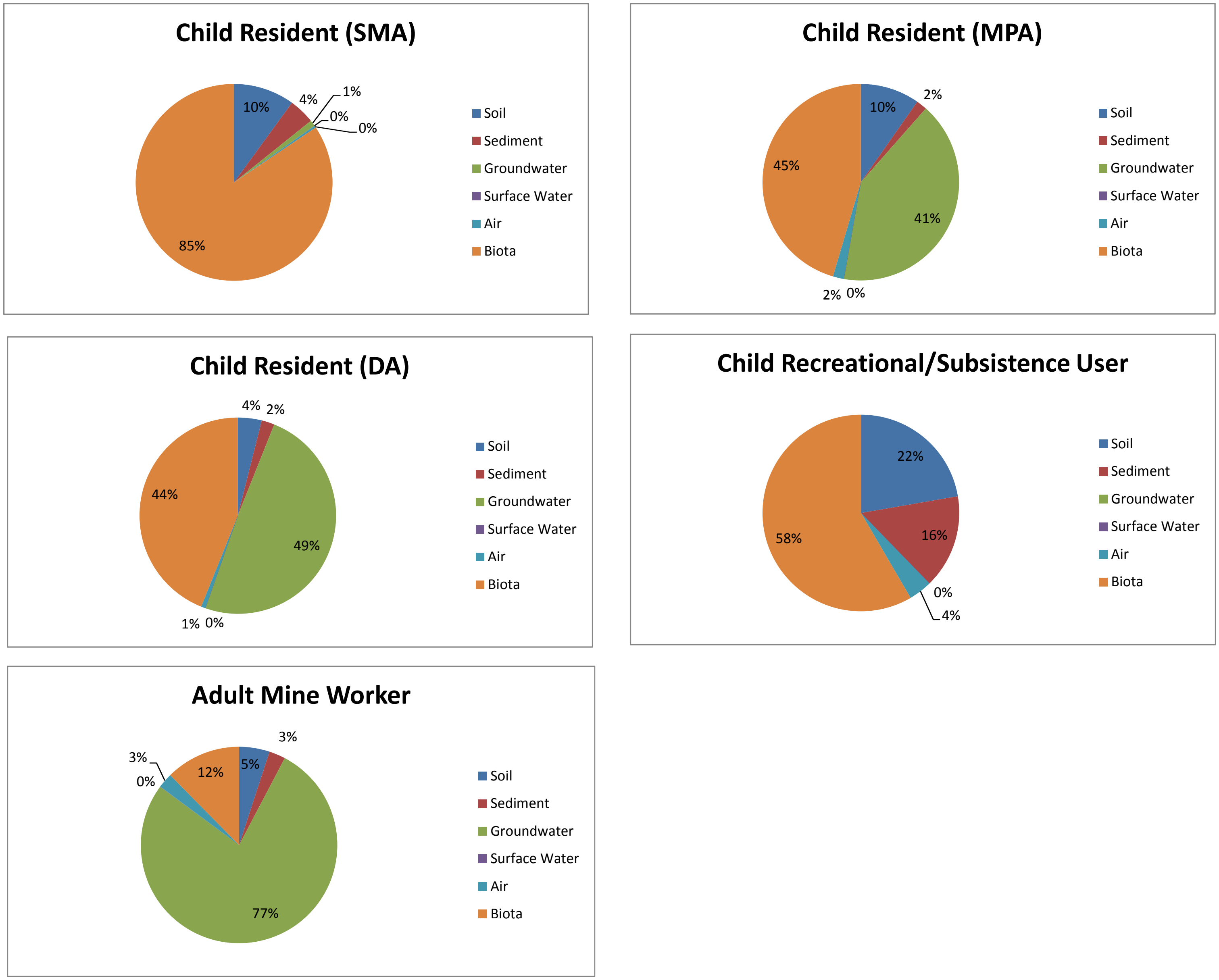
As discussed above and in Section 6.2.3.7, the concentrations of antimony, arsenic, and mercury of game fish modeled from the sculpin from Red Devil Creek greatly exceed the concentrations in northern pike collected from the reach of the Kuskokwim River nearest to the RDM. Using the arsenic fish concentrations in Northern Pike, as shown in Table 6-24, the HI from ingestion of game fish is reduced even further to an HI of 6.8, with mercury contributing 94 percent to the fish ingestion HI.

The HI values for soil, sediment, and air also exceed 1.0. These HI values are driven primarily by arsenic in soil (94 percent of soil ingestion HI) and sediment (100 percent of dermal exposure to sediments), and mercury in air (95 percent of inhalation from soil HI). Ingestion of antimony and mercury in soil for children also slightly exceeded an HQ of 1.0, with HQs of 1.2 for antimony and 1.3 for mercury.

**Main Processing Area –** The total ELCR, including all exposure pathways, for a hypothetical resident in the MPA is $7 \times 10^{-2}$ (or 7 in 100), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing to the ELCR. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include groundwater (61 percent), biota (19 percent), and soil (15 percent).

The inorganic arsenic EPC in groundwater is impacted significantly by two elevated sample results of 4,530 μg/L in 11MP29GW and 1,640 μg/L in 11MP39GW. These results are identified as outliers through analysis with ProUCL and as indicated in the Q-Q plots provided as Figure 6-5. If these two samples are removed from the data set, the groundwater 95 percent UCL decreases from 1,802 μg/L to 50 μg/L. Review of total arsenic concentration in groundwater in the MPA shows a number of wells with elevated total arsenic, indicating that these two elevated inorganic arsenic levels may not be true outliers.

**Figure 6-4. Hazard Index Contribution by Media, Red Devil Mine**



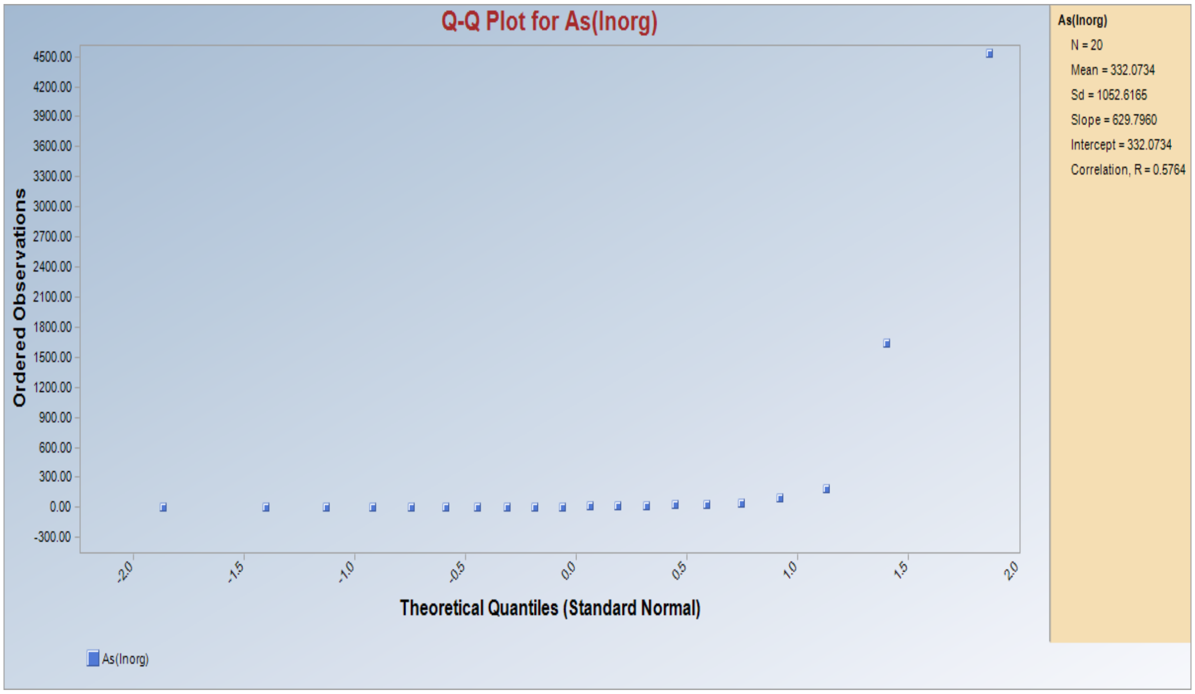



**Figure 6-5 Identification of Inorganic Arsenic Outliers in Groundwater, Q-Q Plot**

The HI, including all exposure pathways, for a hypothetical resident in the MPA is 1295 for adults and 3136 for children, exceeding both ADEC and EPA HI criteria of 1.0. Figure 6-4 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child resident. As for the SMA, child HIs are shown since they represented the potentially highest exposed receptor. Ingestion of biota (primarily fish consumption) contributes 49 percent to the overall HI for adults and 45 percent for children. Adjustment of the FI, as described above, reduces the HI for ingestion biota from 636 to 94 for adults and from 1424 to 210 for children.

As discussed in the section for the SMA, above, it is conservatively assumed that all wild food consumed is harvested from the site. A more realistic estimate would be to use the FI calculated for the recreational/subsistence user, which is based on data obtained from the ADF&G survey of residents of Red Devil Village (Brown et al. 2012). Also, the concentrations in fish were conservatively modeled from sculpin tissue collected in Red Devil Creek. The above discussion regarding FI and modeled fish concentrations for residents in the SMA also is applicable to residents of the MPA, since fish consumption is not influenced by the exposure units.

Ingestion and dermal contact with groundwater contributed 43 percent to the overall HI for adults and 41 percent for children. Risk from exposure to groundwater is driven primarily by antimony and arsenic in groundwater. The HQs for cobalt (child only), manganese, and mercury also exceed an HQ of 1.0.

The HI for soil, sediment, and air also exceed an HI of 1.0. The following COPCs had HQs above 1.0: antimony, arsenic and mercury in soil, arsenic in sediment, and mercury in air (based on soil concentrations).

**Red Devil Creek Downstream Alluvial Area –** The ELCR and HIs for the DA are similar to those for the MPA. The total ELCR, including all exposure pathways, for a hypothetical resident in the DA is 6 x $10^{-2}$ (or 6 in 100), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing to the ELCR. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota).

The HI, including all exposure pathways, for a hypothetical resident in the DA is 1,113 for adults and 2,623 for children, exceeding both ADEC and EPA HI criteria of 1.0. Figure 6-4 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child resident. As for the SMA and MPA, child HIs are shown since they represented the potentially highest exposed receptor. See discussions for SMA and MPA regarding influence of FI and modeled fish concentrations on overall hazards and risks.

Ingestion and dermal contact with groundwater contributed 44 percent to the overall HI for adults and 49 percent for children. Exposure to groundwater is driven primarily by antimony and arsenic in groundwater. The HQs for cobalt (child only), manganese, and mercury also exceed an HQ of 1.0.

The HI values for soil, sediment, and air also exceed 1.0. The following COPCs had HQs above 1.0: antimony, arsenic and mercury in soil, arsenic in sediment, and mercury in air (based on soil concentrations.

### Recreational/Subsistence User

Cancer risks and HIs are calculated for a recreational or subsistence user at the RDM site. The total ELCR, including all exposure pathways, for a recreational/subsistence user is 8 x $10^{-3}$ (or 8 in 1,000), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing to the ELCR. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include sediment (44 percent), soil (32 percent), biota (14 percent) and surface water (10 percent). Unlike the resident, it is assumed that the recreational/subsistence user ingests surface water as a drinking water source while at the site.

The HI, including all exposure pathways, for a recreational/subsistence user is 124 for adults and 358 for children, exceeding both ADEC and EPA HI criteria of 1.0. Figure 6-4 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota) for a child recreational/subsistence user. Child HIs are shown since they represented the potentially highest exposed receptor. Ingestion of biota (primarily fish consumption) contributes 75 percent to the overall HI for adults and 58% for children.

As for residents in the SMA, MPA, and DA discussed above, the concentrations in fish were conservatively modeled from sculpin tissue collected in Red Devil Creek. See discussion for residential receptors above.

The HI for soil, sediment, and air slightly exceeded an HI of 1.0. The following COPCs had HQs above 1.0: antimony, arsenic and mercury in soil, arsenic in sediment, and mercury in air (based on soil concentrations).

### Future Mine Worker

Cancer risks and HIs are calculated for a hypothetical future mine worker at the RDM site. The total ELCR, including all exposure pathways, for a future mine worker is $3 \times 10^{-2}$ (or 3 in 100), exceeding both ADEC and EPA risk standards. Arsenic is the only carcinogenic COPC onsite contributing to the ELCR. Figure 6-2 shows the contribution to risk by media (soil, sediment, groundwater, surface water, air, and biota). Media contributing significantly to risk include groundwater (80 percent), soil (10 percent) and sediment (8 percent).

The HI, including all exposure pathways, for a future mine worker is 566, exceeding both ADEC and EPA HI criteria of 1.0. Figure 6-4 shows the contribution to HI by media (soil, sediment, groundwater, surface water, air, and biota). Ingestion and dermal contact with groundwater (primarily consumption) contributes 77 percent to the overall HI. Consumption of biota contributes 12 percent and dermal ingestion, and dermal contact with soil contributes 5 percent to the overall HI.

### Risks and Hazards at Maximum Groundwater Levels

Consistent with ADEC guidance (2011), risks and hazards are calculated based on the maximum COPC concentrations in groundwater. Using the maximum COPC groundwater concentrations, as presented in Table 6-14, the ELCR from exposure is 1 in 10 and the HI is 3,100, above ADEC and EPA criteria. Risks and hazards are presented in Appendix D, Tables D-11 and D-12, respectively.

### 6.2.5.4 Assessment of Background Contribution to Risk

Consistent with EPA policy (EPA 2002a), COPCs at the RDM site include all compounds that exceed risk-based concentrations, including chemicals that are below background levels. Background levels are presented in Section 4.1. Cancer risks and hazards are presented in Section 6.2.5.3 and include risks and hazards from naturally occurring background levels. Risks from exposure to background level are provided in Appendix D, Tables D-13 through D-15, for the residential, recreational/subsistence user, and mine worker scenarios, respectively. ELCR values from exposure to background levels are summarized in Table 6-32. HIs from exposure to background levels are provided in Appendix D, Table D-16, and are summarized in Table 6-33 for the residential scenario, the most highly exposed receptor. As shown, the ELCR and HI at background levels of metals exceed both the ADEC and EPA criteria.

#### 6.2.5.5 Lead Modeling Results

As discussed in Section 6.2.4.3, risks from exposure to lead were not quantified as they were for other COPCs. Lead modeling was conducted for children using the IEUBK model.

The IEUBK model was run using default parameters except for the inclusion of the concentration of lead in soil, drinking water, and locally harvested wild food, as described in Section 6.2.4.3. Input parameters are provided in Appendix E. The model was run for the most highly exposed receptor, the future child resident in the SMA. Model output is provided in the form of a probability density curve that shows the probability of blood lead concentrations occurring in a hypothetical population of children. This curve shows a plausible distribution of blood lead concentrations centered on the geometric mean blood lead concentration predicted by the model from available information about children's exposure to lead. From this distribution, the model calculates the probability that children's blood lead concentrations will exceed a level of concern (EPA 1994).

EPA and the Centers for Disease Control and Prevention have determined that childhood blood lead concentrations at or above 10 micrograms of lead per deciliter (μg Pb/dL) present risks to children's health (CDC 1991). Therefore, a value of 10 μg/dL is generally used as the blood lead level of concern and is the threshold used in this assessment. The probability density curves designate the percentage of children predicted to have blood lead levels that exceed the threshold. Probability density curves were generated for this site and are provided in Appendix E. The EPA's risk reduction goal for contaminated sites is that no more than 5 percent of the population exposed to lead will have blood lead levels greater than 10 μg/dL (EPA 2003b). The IEUBK model gives potential percentages of children with blood lead levels above 10 μg/dL for the future resident of 0.005 percent. These results are three orders of magnitude below the EPA's 5 percent, indicating that lead does not pose an unacceptable risk at the site.

### 6.2.6 Uncertainty Analysis

Uncertainty is inherent in every step of the risk assessment process. Uncertainty, and its impact on the risk assessment results, is discussed in this section. The risk characterization combines and integrates the results of data collection and evaluation, the exposure assessment, and the toxicity assessment to obtain quantitative estimates of the potential risks posed by site contamination. The following sections and Table 6-34 present some uncertainties associated with each step of the process and the ways they are likely to affect the overall risk estimates.

#### 6.2.6.1 Environmental Sampling and Analysis

Samples collected during the investigations were intended largely to characterize the nature and extent, and fate and transport, of contamination at the site. While this sampling approach is sound for site characterization, it can result in uncertainties in estimating the average concentration, or EPC, that people may contact over time.

For example, many sampling locations were selected in a purposeful or directed manner to focus on particular areas where contamination was known or suspected to be present. Samples collected in this manner provide considerable information about the site but are not statistically representative of contamination that may be present on the site and may overestimate the average concentration to which people may be exposed. For example, biased sampling was conducted in the SMA targeting three ore zones: the originally mined ore zone, Dolly ore zone, and Rice ore zone. Results from these samples showed elevated metal concentrations. Biased sediment sampling in resulted in inclusion of a sample consisting of yellowboy material deposited at a spring, with a total arsenic concentration of 130,000 mg/kg, which is much higher than arsenic concentrations the sediment samples collected in Red Devil Creek. Inclusion of results from biased sampling results in higher EPC concentrations than would be assumed from random exposure.

Characterization of background concentrations of metals at mine sites is important because mines are developed in naturally mineralized areas. In such areas, the concentrations of not only the metals targeted by the mining, but other metals, are commonly elevated. Characterization of background conditions at mine sites may be complicated by the mining and ore processing activities that occur in the vicinity of the site. Such is the case at the RDM site, as discussed in Section 4.1 and below.

As stated in Section 4.1, in order to assess site-specific background conditions at the RDM site, background samples were collected from locations that were recognized as being clearly outside of and upgradient of potential impacts by mining, ore processing, and waste disposal operations. Results of soil samples collected from the selected locations indicate significantly lower concentrations than might be expected in a mining area in general. The likely explanation for this is that the areas excluded from consideration for background soil characterization lie outside of not only the narrow cinnabar ore zones that were mined, but also the somewhat broader generally mineralized zone. As noted in Section 4.1, although cinnabar ore mining was focused on discrete localized ore zones, natural mineralization in the RDM area extends beyond the discrete ore zones that were targeted by mining. This is supported by the observation of elevated arsenic and mercury concentrations from several subsurface soil samples that, although they lie within the overall footprint of the area potentially affected by mining activities, are apparently undisturbed and unaffected by mining and associated activities. It appears that the available soil samples for background characterization are not representative of actual background geological conditions. As a result of the difficulties characterizing representative background soil conditions at the RDM site with the available data, the contribution of background to risk at the site is likely underestimated.

A number of compounds in water were not detected, yet had detection limits above an RBSC. None of these compounds were identified as COPCs in soil or sediment. Based on this, it is not expected that elevated detection limits would have an appreciable impact on overall risk at the site.

#### 6.2.6.2 Exposure Point Concentration Uncertainties

Because of the variability and uncertainty inherent in the sampling and analysis processes, the chemical concentrations reported may differ from the actual chemical concentrations. Uncertainty is introduced by the use of estimated, or J-qualified, results, which may not have the same precision and accuracy as data meeting all standard QC criteria. There is also uncertainty associated with the use of nondetect results, or assuming COPC concentrations are based on the reported limits, which may overestimate or underestimate the true concentrations present.

EPCs in biota were modeled from soil, vegetation, or fish samples. Biota uptake modeling generally results in estimated concentrations that are higher than actual concentrations. As shown in Tables 6-24 and 6-25, the modeled concentrations of COPCs in fish and berries are significantly higher than measured concentrations in game fish and blueberries. EPCs in bird were modeled from concentrations of COPCs in white spruce needles. The arsenic white spruce needle EPC is highly impacted by a single, elevated sample (11MP38WS), located near Red Devil Creek downhill from Settling Ponds #1 and #2. The concentration of arsenic in this single sample is 11.1 mg/kg; the next highest concentration is 0.82 mg/kg. Use of modeled concentrations of COPCs in biota overestimates risks and hazards from consumption of these food sources.

Total mercury concentrations in soil and groundwater were used to estimate elemental mercury concentrations for assessment potential inhalation exposure. Based on results from the SSE in soil from the F0 and F4 fractions, mercury in the volatile form was generally much lower than the total mercury EPC. For this pathway assessment, the assumption that all the total mercury in soil is in the elemental overestimates risk from exposure to volatile, elemental mercury at the site. Exposure to elemental mercury in soil or groundwater, however, did not pose an unacceptable risk or hazard at the site even based on these conservative estimates.

Risks and hazards from consumption of groundwater were determined based on unfiltered sample results. Filtered (or dissolved) metal results are lower in concentration than the total metal results. Construction of new drinking water wells would likely incorporate mechanisms to filter turbid water, resulting in true exposure to COPCs that would more likely be represented by filtered sample results. Use of the total metal concentrations in groundwater overestimates risks and hazards at the site.

#### 6.2.6.3 Exposure Assessment Uncertainties

Selection of appropriate exposure parameters is typically a challenging exercise in conducting an HHRA because it is difficult to make generalizations about potentially impacted populations and site-specific exposure studies are very rare. Nevertheless, the risk assessor must make the best assumptions possible based on available information. While there are limited studies available for contact with soil, even fewer studies have been conducted to estimate exposures to sediment, in terms of frequency of contact, adherence of sediment to skin, and incidental ingestion of sediment through hand-to-mouth contact. For this reason, many sediment ingestion and dermal exposure parameters are based on studies of human contact with soil, which may result in an under- or overestimation of risk.

The individual exposure parameter values used in the RME calculations were selected to represent a high-end estimate of exposure for an individual that is a conservative, or protective, estimate of actual exposures. The exposure values selected were either standard default values consistent with ADEC and EPA guidelines, or were conservatively protective estimates selected based on best professional judgment. As a result, the calculated potential exposures probably overestimate the actual exposure for most individuals in the receptor populations.

As briefly mentioned above, additional uncertainty is associated with the procedures used to estimate dermal absorption of chemicals from sediment, specifically $ABS_{dermal}$ and AFs. Uncertainties with this approach arise from the limited information available on sediment-specific values and the application of soil values to represent exposure to sediment. Dermal absorption of COPCs in sediment was estimated using conservative absorption factors for soil recommended by EPA. The recommended default values, which generally fall at the upper ends of the ranges that have been observed in absorption studies, may not reflect actual dermal absorption for sediment.

Arsenic concentrations are adjusted to reflect the bioaccessibility of Red Devil Mine arsenic. Default values were used for arsenic bioavailability but are known to be highly uncertain (EPA 2003a). The in vitro bioaccessibility assay is based on the concept that arsenic solubilization in gastrointestinal fluid is likely to be an important determinant of arsenic bioavailability in vivo. The method measures the extent of arsenic solubilization in an extraction solvent that resembles gastric fluid. The results may be affected by sample location selection, sample handling and inadvertent variations in the extraction protocol. Use of a default adjustment for bioavailability factor likely overestimates risk at the site based on the site-specific bioaccessibility results provided in Table 6-23. Bioaccessibility sample results indicate that arsenic in background soils may be more bioavailable than site samples.

All other metals at the site were conservatively assumed to be 100% bioavailable which overestimates risks and hazards at the site.

Ingestion rates used in this HHRA are based on a 12-month recall survey on harvest data. The survey was conducted on a household basis. As previously mentioned, harvest data significantly overestimates consumption for some resources (IDM 1997). The harvest rates were adjusted to estimate ingestion on an individual basis. Only household harvest data were available, and energy requirement estimates were used to assign an ingestion rate for children. These adjustments likely overestimate true ingestion of wild food at the site. In addition, the residential scenario was determined based on the assumption that all wild food was harvest from the site. Based on Brown et al. (2012), this assumption greatly overestimates actual harvest patterns, as shown for the resident in Figure 6-3.

#### 6.2.6.4 Toxicity Assessment Uncertainties

The basic uncertainties associated with the derivation of toxicity values in the toxicity assessment include:

- Uncertainties arising from the design, execution, or relevance of the scientific studies that form the basis of the assessment.
- Uncertainties involved in extrapolation from the underlying scientific studies to the exposure situation being evaluated, including variable responses to chemical exposure within human and animal populations, between species, and between routes of exposure.

These uncertainties could result in a toxicity estimate based directly on the underlying studies that either underestimates or overestimates the true toxicity of a chemical. The toxicity assessment process compensates for these basic uncertainties through: the use of uncertainty factors and modifying factors in the derivation of RfDs for assessing noncarcinogenic effects; and the method of calculating the 95 percent UCL value from the linearized multistage model to derive low-dose SFs for assessing cancer risks. This approach ensures that the potential toxicity of a chemical to humans is unlikely to be underestimated; however, actual toxicity may be substantially overestimated as a result. There is significant uncertainty in how to address risks from mutagenic compounds.

The use of adjusted oral toxicity values to evaluate dermal risks is an additional source of uncertainty to the dermal risk estimates because the biokinetics (uptake, distribution, metabolism, and elimination) from dermal exposure may be different from ingestion.

In the absence of information to the contrary, EPA guidelines indicate that carcinogenic risks should be treated as additive and that HIs for similar noncarcinogenic effects should also be treated as additive. The assumption of risk additivity ignores possible synergisms or antagonisms among different chemicals, which would increase or decrease their toxic effects and could tend to underestimate or overestimate total site risks.

No toxicity data were available for 4-bromophenyl phenyl ether. Not quantitatively evaluating 4-bromophenyl phenyl ether may slightly underestimate potential hazards at the site. In some instances, toxicity data for surrogate compounds were used, which may over- or underestimate the toxicity of the compound.

### 6.2.6.5 Risk Characterization Uncertainties

As explained earlier, intentionally conservative, health-protective assumptions are used throughout the risk assessment process so that the true risk is unlikely to be underestimated. The cumulative effect of this approach could be to substantially overestimate the true risk at the site.

The IEUBK model was not specifically designed to account for lead in locally caught food, especially at consumption rates consistent with a subsistence level. The model was adjusted to account for this exposure pathway, but uncertainty in the adjustments may over- or underestimate the risk at the site.

Risks were assessed based on whole food concentrations; impact on chemical intake based on food preparation, or on an "as consumed" level, was not considered. Food preparation methods could have an impact on chemical concentrations, which could result in an over- or underestimation of risks.

As discussed in Section 6.2.6.1, characterization of background concentrations of metals at mine sites is important because mines are developed in naturally mineralized areas. The characterization of risk and hazards at this site included levels of some metals that may be naturally occurring. The attribution of the background risk, based on the assessment of background concentration from Section 4.1, is discussed in Section 6.2.5.4. In addition, it appears that the available soil samples for background characterization are not representative of actual background geological conditions. As a result of the difficulties in characterizing representative background soil conditions at the RDM site with the available data, the contribution of background to risk at the site is likely underestimated, and the overall risk and hazard based on site-related COPCs and concentrations is likely overestimated.

Red Devil Creek is a first order stream containing less than 2200 meters of stream that drain a 289-hectare (HA) watershed. Red Devil Creek was the smallest stream sampled in terms of stream discharge, basin area, and stream length. Red Devil Creek primarily flows northerly and is located upriver from the community of Red Devil.

Telemetric studies on burbot and northern pike show that movements can be highly variable and difficult to predict for a given river system. In a system comparable to the Holitna River, 70 northern pike were radio-tagged in the lower 40 kilometers (km) of the Nowitna River, which is a major tributary to the Yukon River. The lower 40 km is excellent feeding and spawning habitat because it is dominated by large sloughs. For overwintering, all the northern pike vacated the lower river; approximately half of these fish migrated to the mainstem Yukon River to overwinter for approximately 6 months, whereas the other half traveled up to 160 km upstream to riffle-pool sections of the Nowitna River, where higher dissolved oxygen concentration were likely present. Additional telemetry data and results will assist in determining site contribution of mercury levels in fish (Varner 2012).

## 6.3 Baseline Ecological Risk Assessment

### 6.3.1 Introduction

This section presents the BERA for the RDM site. The purpose of the BERA is to determine whether or not residual contamination from historical mining activities poses risks to ecological receptors at the site. The results of the BERA will be used to determine whether or not remedial measures may be necessary in order to protect the natural environment and, if so, aid in the selection of appropriate remedial goals. The BERA is consistent with federal and state ecological risk assessment guidance documents including:

- *Ecological Risk Assessment Guidance for Superfund* (ERAGS)*: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997).
- *Guidelines for Ecological Risk Assessment* (EPA 1998).
- *Wildlife Exposure Factors Handbook* (EPA 1993).
- *Guidance for Developing Ecological Soil Screening Levels* (EPA 2005a).
- *Risk Assessment Procedures Manual* (ADEC 2011).

In addition to the state and federal guidance documents noted above, this assessment also used publications from Oak Ridge National Laboratory (ORNL) and articles from the peer-reviewed literature, as appropriate.

The remainder of this section is organized as follows:

- Section 6.3.2 describes the RDM site and its ecological resources.
- Section 6.3.3 presents a summary of the SLERA for the RDM site (ERAGS Steps 1 and 2).
- Section 6.3.4 presents a problem formulation for the BERA (ERAGS Step 3).
- Section 6.3.5 describes the study design for the field efforts used to collect data for the BERA (ERAGS Steps 4 and 5).
- Section 6.3.6 presents the exposure assessment and risk characterization for the assessment endpoints evaluated in the BERA, including terrestrial plants, soil invertebrates, benthic macroinvertebrates, fish and other aquatic organisms exposed to surface water, and wildlife (ERAGS Steps 6 and 7a).
- Section 6.3.7 discusses sources of uncertainty in the BERA (ERAGS Step 7b).
- Section 6.3.8 presents preliminary clean-up levels for key risk drivers (ERAGS Step 8).
- Section 6.3.9 provides a summary and recommendations.

### 6.3.2 Site Location and Ecology

This section focuses on the habitats and ecological characteristics of the site that are pertinent to the BERA. The information provided below is based on earlier site reports (HLA/Wilder 2001) and observations made by E & E and BLM personnel during field activities at the site (BLM 2010; E & E 2010a).

#### 6.3.2.1 Site Overview

The RDM site is an abandoned mercury mine and ore processing site on the south bank of the Kuskokwim River in a remote area of Alaska, approximately 250 air miles west of Anchorage, Alaska (see Figure 1-1). The site is located on public land managed by the BLM and for the purposes of the BERA consists of four main areas: Surface Mined Area, Main Processing Area, Red Devil Creek Area, and Kuskokwim River Area (see Figure 1-2). Significant mine area surface features, lithologic units, and soil types are shown on Figures 1-5, 1-7, and 3-1, respectively. A detailed description of the site and its operational history is provided in Section 1.4.

#### 6.3.2.2 Climate

The RDM site is located in the upper Kuskokwim River Basin and lies in a climatic transition between the continental zone of Alaska's interior and the maritime zone of the coastal regions. Average temperatures can vary from –7 to 65 °F (–22 to 18 °C). Annual snowfall averages 56 inches (142 cm), with a total mean annual precipitation of 18.8 inches (48 cm). The Kuskokwim River is ice-free from mid-June through October.

#### 6.3.2.3 Vegetation

The vegetation around the RDM site is characterized by spruce-poplar forests and upland spruce-hardwood forests. During the 2010 sampling season, vegetation characteristics were recorded at surface soil sample locations. Observations documented include the percent cover of vegetation in each of three layers or strata: (1) trees (woody vegetation with diameter at breast height [DBH] > 3 inches and over 15 feet tall); (2) samplings/shrubs (woody vegetation with DBH < 3 inches); and (3) herbs (non-woody vegetation). Trees observed included Sitka alder (*Alnus sinuata*), black cottonwood (*Populus trichocarpa Torr. & Gray*), quaking aspen (*Populus tremuloides*), and willow (*Salix sp.*). Saplings and shrubs observed included Sitka alder, black cottonwood, and willow. The dominant species in the herb strata included horsetail (*Equisetum sp.*), various grasses (*Poa sp.* and other unidentified species), ferns (*Athyrium sp.*), various weedy plants (e.g., *Epilobium sp.*), and moss.

Vegetative cover in the Main Processing Areas was limited, often consisting of only moss and occasional patches of grass. Cover in this area ranged widely, from 0 to 90 %, represented almost entirely by moss. If moss were removed from this category, vegetative cover would likely be less than 10%. These areas offer limited soils and were heavily compacted in locations subjected to vehicular travel; a majority of the surface material consisted of rock. On the perimeter of the disturbed areas, such as around the processing areas, on the sides of the roads, and along the slopes leading to the creek, saplings were more common, making up 15 to 100 % of vegetative cover. Sitka alder and black cottonwood were the prevalent species occurring in these areas. In areas that showed no sign of disturbance in recent years, vegetation cover was dominated by trees (between 10 and 75 %) and saplings (between 20 and 100%).

The area of Red Devil Creek north of the Main Processing Area, between the two roads, and in the vicinity of Settling Ponds #2 and #3, was dominated by Sitka alder and black cottonwood trees and saplings with ferns, grasses, and horsetail in the lower strata. Settling Pond #1 was dominated by horsetails.

In general, the disturbed Surface Mined Area of the RDM site had a thick growth of saplings and trees with moderate understory coverage. Vegetation in the upper strata consisted largely of Sitka alder saplings and trees with black cottonwood and occasional quaking aspen trees. The herb layer in this area was dominated by ferns, grasses, and weedy plants. The vegetation in the Dolly Sluice and Rice Sluice areas was similar in nature, and neither appeared to have any stressed vegetation. The vegetation did not consist of any large alder trees in the channel area of either sluice.

#### 6.3.2.4 Red Devil Creek and Kuskokwim River Biota

**Red Devil Creek**

Red Devil Creek runs through the middle of the Main Processing Area and discharges to the Kuskokwim River. A historical bridge, now collapsed, crossed the creek and connected the two sides of the Main Processing Area. In the vicinity of the former bridge location, large piles of tailings and/or waste rock make up the creek banks. The creek contains some metal and other debris, likely from past mining activities.

During field work in fall 2010, water depth in the creek varied from 3 to 12 inches at locations where surface water and sediment were sampled in fall 2010. Current velocity appeared to decrease upstream of the Main Processing Area, and pool/riffle structure was more frequently observed in addition to woody material. Stream discharge was measured on August 18, 2011, at locations along Red Devil Creek collocated with sediment and surface sampling stations. Estimated discharge rates showed a general increase from 5.52 cubic feet/second near the upstream end of the Main Processing Area (station RD10) to 7.19 cubic feet/second at the confluence with the Kuskokwim River. Further discussion of discharge is provided in Section 3.3.1. In 2010, BLM staff collected fish from Red Devil Creek for contaminant analysis (BLM 2010). Slimy sculpin (*Cottus cognatus*, 6 to 9 cm in length), juvenile Dolly Varden (11 to 17 cm in length), and juvenile salmon (8 to 11 cm in length) were collected for analysis. No large game fish were found by the BLM in Red Devil Creek, likely due to the creek's shallow depth and narrow width. Also in 2010, BLM collected composite samples of two different mayfly genera—*Baetis* spp. and *Cinygmula* spp.—from the creek. *Baetis* spp. and *Cinygmula* spp. are small mayfly species, requiring the BLM to include several hundred individual organisms in each 1-gram composite sample. In fall 2010, the E & E field team that collected sediment from the creek reported seeing numerous small benthic invertebrates and their casings on the undersides of rocks throughout the creek. The small benthic invertebrates observed by the E & E field team likely were mayfly larvae. The E & E field team also observed other benthic invertebrates, including midge (Family Chironomidae) and cranefly (Family Tipulidae) larvae, during sediment sampling. Lastly, the E & E field team reported that moss and brown algae were present in the creek and generally appeared to trend toward increased coverage as sample locations progressed upstream from the Kuskokwim River, but that moss and algae were not present at all sample locations.

**Kuskokwim River**

The Kuskokwim River is a major anadromous fish river (HLA/Wilder 2001). Fish found in the river in the vicinity of RDM site include whitefish (*Coregonus sp.*), Arctic grayling (*Thymallus arcticus*), sheefish (*Stendous leucichthys nelma*), Dolly Varden (*Salvelinus malma*), burbot (*Lota lota*) and northern pike (*Esox lucius*), as well as chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*), and chum salmon (*O. keta*) (HLA/Wilder 2001; BLM 2010). Additional information on the Kuskokwim River is provided in Section 3.3.2.

#### 6.3.2.5 Mammals

Moose (*Alces alces*), wolves (*Canis lupis*), black bears (*Ursus americanus*), brown bears *Ursus arctos*), lynx (*Lynx canadensis*), martens (*Martes spp*.), foxes (*Vulpes vulpes*), beavers *Castor canadensis*), minks (*Neovision vison*), muskrats (*Ondatra zibenthicus*), otters (*Lutra canadensis*), and various small rodents are known to occur in the area (HSA/Wilder 2001). During field activities in September 2010, three river otters (*Lontra canadensis*) were observed in the Kuskokwim River near the mouth of Red Devil Creek. In addition, moose and bear (*Ursus sp.*) tracks were observed near the upper pond and bear tracks were also observed near the mouth of Red Devil Creek.

#### 6.3.2.6 Birds

The upper Kuskowkim River is a low density waterfowl area (HLA/Wilder 2001). Nonetheless, according to ADEC staff, there have been reports of waterfowl (species not specified) using the settling ponds near the Main Processing Area. Songbird species that migrate through the area include the olive-sided flycatcher (*Contopus cooperi*), gray-cheeked thrush (*Catharus minimus*), Townsend's warbler (*Dendroica townsendi*), blackpoll warbler (*D. striata*), and Hudsonian godwit (*Limosa haemastica*) (HLA/Wilder 2001). A raptor survey done on the Kuskokwim River in July 2000 found an active peregrine falcon (*Falco peregrinus*) nest seven miles downstream from the RDM, on rock cliffs on the north side of the river (BLM 2001). Finally, during field work in September 2010, many spruce grouse (*Dendragapus canadensis*) were observed on and near the RDM site, and an osprey (*Pandion haliaetus*) was observed foraging in the Kuskokwim River near the site.

#### 6.3.2.7 Special Concern Species

**Federally Listed Species**

The United States Fish and Wildlife Service (USFWS 2011) lists four species as being either endangered, threatened, or candidate species for Bethel County, Aalaska. These species are:

- Short-tailed albatross (*Phoebastria albatrus*), federally listed endangered
- Spectacled eider (*Somateria fischeri*), federally listed threatened
- Steller's eider (*Polysticta stelleri*), federally listed threatened
- Kittlitz's murrelet (*Brachyramphus brevirostris*), federal candidate species.

Given their habitat preferences, none of these species are likely to occur at the RDM site. The short-tailed albatross is a sea bird that is sighted occasionally along the west coast of Alaska. The two eider species breed on wet low-lying tundra along the north and west coasts of Alaska (Kaufman 1996). In other seasons, the spectacled eider and Steller's eider occur along the coast, where they forage by diving, mostly for mollusks. Kittlitz's murrelet is found along the Alaska coastline, being common mainly from Kodiak Island east to Glacier Bay (Kaufman 1996). It prefers cold sea waters, mostly in calm protected bays and among islands, usually close to shore.

**State Listed Species**

The Alaska Natural Heritage Program was contacted for current information on plant and animal species of concern in the vicinity of the RDM site. When available, the information provided by the Alaska Natural Heritage Program will be added to the BERA.

### 6.3.3 Summary of Screening Level Ecological Risk Assessment and Decision to Proceed with Baseline Ecological Risk Assessment (ERAGS Steps 1 and 2)

A draft SLERA for the RDM site was submitted to the EPA and ADEC in mid-January 2012. The draft SLERA was revised based on agency comments and is included in this report as Appendix F. Also included in Appendix F are responses to agency comments.

The SLERA was conducted in accordance with the EPA Ecological Risk Assessment Guidance for Superfund (ERAGS) and State of Alaska ecological risk assessment guidance. A full set of ecologically relevant assessment endpoints were evaluated, including: terrestrial-plant community, soil-invertebrate community, benthic-macroinvertebrate community, fish and other aquatic biota in Red Devil Creek, terrestrial wildlife, and aquatic-dependent wildlife. Potential risks to communities of terrestrial plants, soil invertebrates, benthic macroinvertebrates, and fish and other aquatic biota were evaluated by comparing maximum detected chemical concentrations in surface soil, sediment, surface water, and whole-body sculpin samples with conservative screening levels for these media. Media screening levels were taken from the final RAWP for the RDM site, except those for fish tissue and a second water quality criterion for mercury, which were added to the revised SLERA based on EPA comments. Potential risks to terrestrial and aquatic-dependent wildlife were evaluated by calculating screening-level exposure estimates and HQs as per EPA guidance.The 11 wildlife endpoint species identified in the final RAWP were included in the evaluation. These species are: American robin, masked shrew, spruce grouse, tundra vole, northern shrike, least weasel, common snipe, beaver, green-winged teal, belted kingfisher, and mink. Exposure parameters and toxicity reference values were taken from the final RAWP. The wildlife evaluation was based on maximum measured chemical concentrations in site surface soil, sediment, surface water, vegetation, and fish and benthic macroinvertebrates from Red Devil Creek. Conservative modeling approaches were used to estimate chemical concentrations in the prey of terrestrial predatory wildlife species (robin, shrew, weasel, and mink).

The primary purpose of the SLERA was to select COPCs for the BERA for the Red Devil Mine site. Table 6-35 provides a summary of the chemical and receptor combinations that were evaluated in the BERA based on the SLERA. For each assessment endpoint, chemicals were retained for evaluation in the BERA if the screening-level HQ was greater than or equal to 1 or if the chemical was detected in site media and no toxicity information was available for that chemical. The latter group of chemicals included several organic compounds that were detected infrequently at low (part per billion) levels in soil or sediment (see Table 6-35).

Based on discussions between E & E and the BLM regarding the results of the SLERA, the BLM directed E & E to perform a BERA for the site.

### 6.3.4 Baseline Ecological Risk Assessment Problem Formulation

Problem formulation is the first step in the risk assessment process. It identifies the goals, breadth, and focus of the assessment (EPA 1997, 1998). The problem formulation step identifies COPCs, potential ecological receptors, and potential exposure pathways. A CSM is then developed to summarize the relationship between COPCs and receptors. Lastly, assessment endpoints and measures are developed to guide the remaining steps of the risk assessment process. The BERA problem formulation and CSM for the RDM site are presented in this section. Also identified in this section are the data used to complete the BERA.

#### 6.3.4.1 Contaminant Sources and Migration Pathways

The RDM was Alaska's largest mercury mine, producing 1.2 million kg (2.73 million pounds) of mercury between 1933 and 1971 (Bailey et al. 2002). Cinnabar and stibnite are the principal metallic minerals associated with the mineralized zone targeted by mining, with minor amounts of realgar, orpiment, and pyrite ($FeS_2$) also locally present. High-grade ore contained as much as 30% mercury by weight, but most ore contained 2% to 5%. Several hundred meters of trenches, where surface mining took place, are present on the site. In addition, accumulations of tailings, waste rock, and flotation tailings are located on the site, and several of these lie along Red Devil Creek. During a site investigation by the U (Bailey et al. 2002), abundant cinnabar, lesser amounts of stibnite, and a few beads of liquid mercury were visible in Red Devil Creek. Additional information on the RDM site and previous site investigations is provided in Chapter 1.

Contaminated soil, tailings, waste rock, flotation tailings, and other wastes from the RDM have been exposed at the surface for decades. Mercury and other metals in these wastes were subject to transport by water and wind to Red Devil Creek, the Kuskokwim River, groundwater beneath the site, and surrounding terrestrial areas. In addition, liquid mercury at the site was subject to volatilization to the atmosphere. Chapters 4 and 5 discuss the nature and extent of contamination and contaminant fate and transport in detail based on soil, sediment, surface water, and groundwater data collected in 2010 and 2011. Particular attention is given to arsenic, antimony, and mercury because they are the principal contaminants at the site. Elevated levels of arsenic, antimony, and mercury were found across the site in surface and subsurface soil. The greatest concentrations were found in the Pre-1955 and Post-1955 Main Processing Areas that are situated on either side of Red Devil Creek. Elevated levels of these elements also were found in sediment and surface water in Red Devil Creek near and downstream from the Main Processing Area and in the Kuskokwim River near the point of entry of the creek into the river. Details can be found in the Chapters 4 and 5.

#### 6.3.4.2 Contaminants of Potential Concern and Refinement of COPC List

The SLERA identified antimony, arsenic, and mercury as the principal COPCs at the RDM site based on the magnitude of the HQs for these elements and their widespread distribution at high levels across the site (see Table 6-35). The other metals identified as COPCs in Table 6-35 appear to be of lesser concern. Nonetheless, to conclusively demonstrate so, all metals identified as COPCs in the SLERA were carried forward into the BERA.

Low molecular weight polycyclic aromatic hydrocarbons (LPAHs) and several SVOCs were identified as COPCs in the SLERA for some receptors because they were detected in surface soil or sediment, but no toxicity data were available to quantitatively evaluate them (see Table 6-35). However, for the following reasons, it seems unlikely that these chemicals are of concern at the site:

- They were detected infrequently at low (part per billion) concentrations (see SLERA Tables 4-1 and 4-2); or
- They are not suspected of being from historical mining or ore-processing and appear to be related to other sources, such as the surgical gloves used during sample handling, laboratory sample processing, long-range atmospheric transport and deposition, and/or organic matter decomposition.

Hence, these chemicals are not addressed further in the BERA.

#### 6.3.4.3 Ecological Receptors

Based on the site ecology, the following ecological receptor groups have the potential to be affected by site-related contaminants at the RDM site:

- Terrestrial plants and invertebrates.
- Mammals and birds that use the mine site, Red Devil Creek, and Kuskokwim River near the site to satisfy their food and habitat needs.
- Aquatic biota (e.g., amphibians, benthos, and fish) in Red Devil Creek and the Kuskokwim River.

#### 6.3.4.4 Ecological Conceptual Site Model

The ecological CSM used in the revised SLERA is considered complete. Figure 6-6 provides the ecological CSM for the BERA featuring the receptor groups identified in the previous section and that were initially evaluated in the SLERA. Terrestrial plants may be exposed to site-related chemicals by direct contact with contaminated soils, tailings/waste rock, flotation tailings, and overburden. Terrestrial invertebrates may be exposed to site-related contaminants through direct contact with contaminated soils, tailings/waste rock, flotation tailings, and overburden; ingestion of contaminated soils, tailings/waste rock, flotation tailings, and overburden; and through the food chain. Birds and mammals may be exposed to site-related chemicals through incidental ingestion of soil/sediment, tailings/waste rock, flotation tailings, and overburden; consumption of contaminated prey; and ingestion of contaminated surface water. It should be noted, however, that surface water ingestion typically accounts for only a small fraction (less than 1%) of total exposure for wildlife and therefore is considered a minor pathway. Dermal exposure of wildlife to site-related chemicals is expected to be negligible due to the protection provided by their external coverings (heavy fur and feathers). Fish and benthic invertebrates in Red Devil Creek and the Kuskokwim River may be exposed to site-related chemicals through direct contact with and ingestion of contaminated sediment and surface water and through the food chain.

#### 6.3.4.5 Assessment Endpoints, Measures, and Associated Risk Questions

Assessment endpoints are expressions of the ecological resources that are to be protected (EPA 1997). An assessment endpoint consists of an ecological entity and a characteristic of the entity that is important to protect. According to the EPA (1998), assessment endpoints do not represent a desired achievement or goal and should not contain words such as “protect” or “restore,” or indicate a direction for change such as loss or increase. Assessment endpoints are distinguished from management goals by their neutrality (EPA 1998).

Measurements used to evaluate risks to the assessment endpoints are termed “measures” and may include measures of effect, measures of exposure, and/or measures of ecosystem or receptor characteristics (EPA 1998). Based on the site ecology, COPCs, and CSM, the ecological resources potentially at risk at the RDM site include terrestrial vegetation and invertebrates, mammals, birds, and aquatic biota (fish, amphibians, benthos, and other aquatic organisms). The assessment endpoints and measures for the BERA are listed in Table 6-36.

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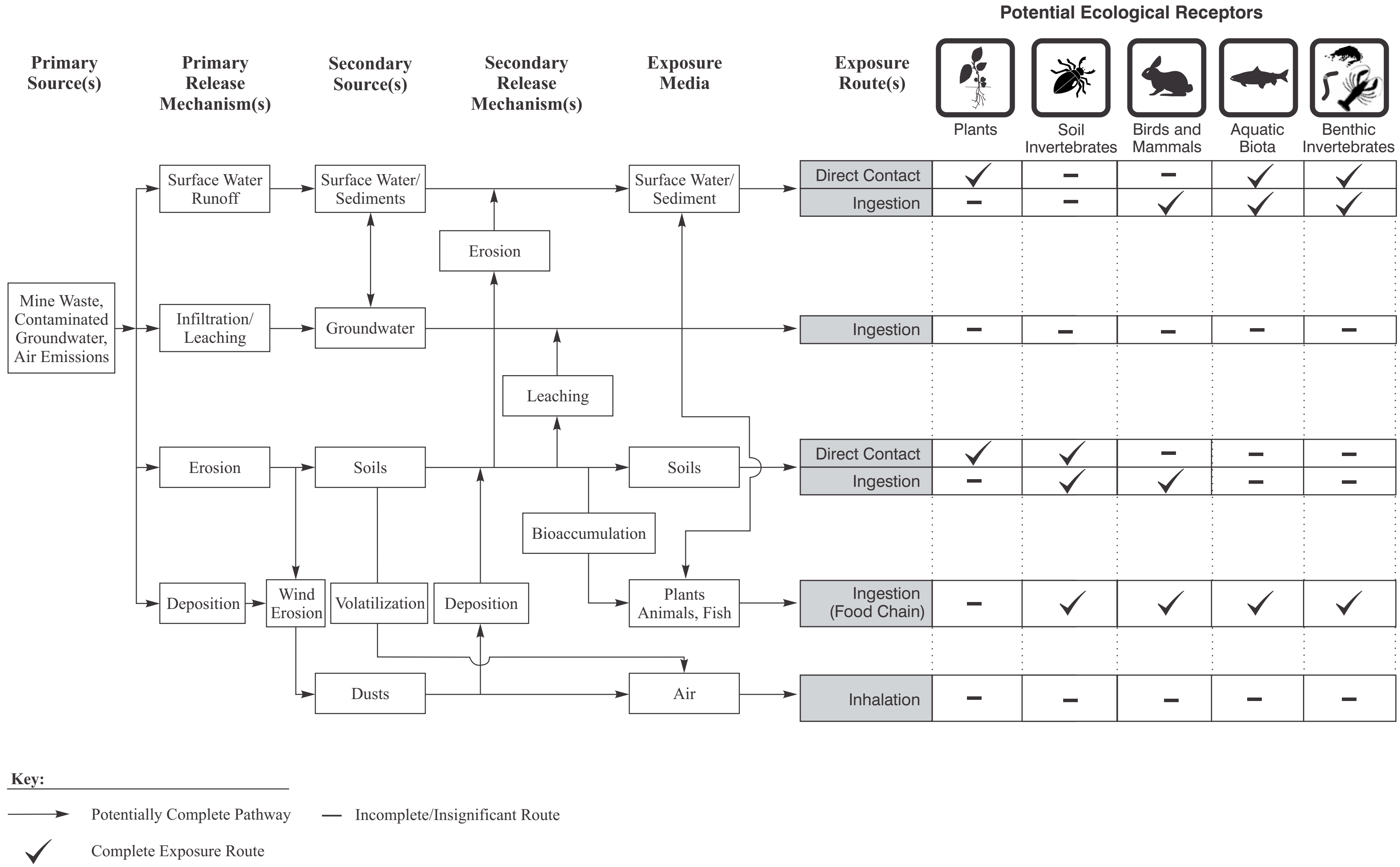


| Exposure Route(s) | Plants | Soil Invertebrates | Birds and Mammals | Aquatic Biota | Benthic Invertebrates |
|---|---|---|---|---|---|
| Surface Water/Sediment – Direct Contact | ✓ | – | – | ✓ | ✓ |
| Surface Water/Sediment – Ingestion | – | – | ✓ | ✓ | ✓ |
| Groundwater – Ingestion | – | – | – | – | – |
| Soils – Direct Contact | ✓ | ✓ | – | – | – |
| Soils – Ingestion | – | ✓ | ✓ | – | – |
| Plants Animals, Fish – Ingestion (Food Chain) | – | ✓ | ✓ | ✓ | ✓ |
| Air – Inhalation | – | – | – | – | – |

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Seattle, Washington

RED DEVIL MINE

Figure 6-6
ECOLOGICAL CONCEPTUAL SITE MODEL FOR RED DEVIL MINE SITE

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### 6.3.5 Study Design (ERAGS Steps 4 and 5)

The study design and data quality objectives for collection and analysis of soil, sediment, surface water, vegetation, fish, and benthic invertebrates from the site are included in the following planning documents:

- 2010 RI/FS Work Plan (E & E 2010b).
- 2011 RI/FS Work Plan (E & E 2011).
- Addendum to 2011 RI/FS Work Plan to support vegetation sampling at the RDM site.
- Addendum to 2011 RI/FS Work Plan to support off-shore sediment sampling in the Kuskokwim River.
- Final Operations Plan (BLM 2010) for collection of fish and benthic macroinvertebrates from Red Devil Creek, nearby reference creeks, and the middle Kuskokwim River.

These planning documents were reviewed by the ADEC and EPA and revised as appropriate based on agency comments. The sampling and analysis described in these documents provided the data used in the BERA.

### 6.3.6 Analysis of Ecological Exposures and Risk Characterization (ERAGS Steps 6 and 7)

Analysis of ecological exposures and risk characterization is discussed under seven main headings: (1) Data Used in the BERA; (2) Terrestrial Vegetation Community; (3) Soil Invertebrate Community; (4) Benthic Macroinvertebrate Community; (5) Aquatic Biota Exposed to Surface Water; (6) Fish Community; and (7) Wildlife. A primary objective of this section is to further evaluate the COPCs identified in the SLERA to arrive at a reduced list of chemicals of concern (COCs) for ecological receptors at the site. The COCs thus identified may become the focus of risk management actions.

#### 6.3.6.1 Data Used in the BERA

The BERA is based on chemical data for surface soil (0 to 2 feet bgs), sediment (0 to 4 inches below the sediment surface), surface water, and vegetation samples collected from the RDM site in 2010 and 2011 for the RI/FS. Full analytical results are presented earlier in this report for surface soil (Tables 4-17 to 4-23), surface water (Table 4-31), sediment (Tables 4-32 and 4-33), and vegetation (Table 4-34 to 4-37). Summaries of these data are included in this chapter as appropriate. In addition, metals data for sculpin and benthic macroinvertebrates from Red Devil Creek collected by the BLM (2010) were used to help evaluate potential risks to aquatic-dependent wildlife. These data were provided to E & E in electronic form in April 2011; no report presenting these data is presently available.

Section 2 of this RI report includes sample locations maps for surface soil (Figures 2-3 and 2-4), surface water (Figure 2-8), sediment (Figures 2-9 to 2-11), and vegetation (Figure 2-12). Section 2 also identifies the analyses performed for surface soil (Table 2-2), surface water (Table 2-6), sediment (Tables 2-7 to 2-9), and vegetation (Table 2-10). Metals, including arsenic, antimony, and mercury, were the principal target analytes in all media. A limited number of soil, sediment, and surface water samples were analyzed for SVOCs. A limited number of soil samples also were analyzed for PCBs, as Aroclors. However, as noted in Section 6.3.3, no organic contaminants were carried forward into BERA.

Section 6.1 provides a discussion of the usability of the RI data for risk assessment purposes. For analytes that were carried forward into the BERA, EPCs were calculated with the latest version of ProUCL (EPA 2010d). In most cases, the 95% UCL on the average concentration was used as the EPC. If too few samples were available to calculate a 95% UCL, the maximum detected concentration was used as the EPC. Appendix G includes summaries of the ProUCL output. Field duplicate sample results were handled as per ADEC (2008c) guidance.

#### 6.3.6.2 Terrestrial Vegetation Exposure Assessment and Risk Characterization

The 13 metals identified in the SLERA as COPCs for the terrestrial plant community (see Section 6.3.3) are evaluated further in this section. COCs for this community were identified by calculating an HQ for each metal based on its surface soil EPC and soil screening level. The results are shown in Table 6-37. The following points are noteworthy:

- The HQs for arsenic, cobalt, manganese, mercury, nickel, and vanadium exceeded 1.
- The greatest HQs were for arsenic (198) and mercury (839), and a large percentage of samples, exceeded the screening levels for these analytes.
- The HQs for manganese (3.4) and vanadium (17.4) at the RDM site, although greater than 1, were less than the background HQs for manganese (3.7) and vanadium (29.2) (see Table 4-2 for surface soil background levels). This result suggests that any potential risk to terrestrial plants from manganese and vanadium at the RDM site are not related to historical mining operations.
- The cobalt HQ (1.4) and nickel HQ (1.4) at the RDM site were only marginally greater than 1. Because of the conservative nature of the available soil screening levels for plants, it seems unlikely that these metals pose an actual risk to terrestrial plants at the RDM site.
- Antimony, barium, and beryllium were identified as COCs for the terrestrial plant community because they were detected in site surface soil, but no reliable screening level was available. Each of these metals was detected in a large percentage of site samples (see Table 6-37), and the site surface soil EPCs exceeded the background levels, especially for antimony (compare Table 6-37 and Table 4-2).

In summary, it appears that arsenic and mercury are the analytes with the greatest potential to adversely affect the terrestrial plant community at the RDM site. Antimony may also be of concern for terrestrial plants, given the factors discussed above.

#### 6.3.6.3 Soil Invertebrate Community Exposure Assessment and Risk Characterization

The 13 metals identified in the SLERA as COPCs for the soil invertebrate community (see Section 6.3.3) are evaluated further in this section. COCs for this community were identified by calculating an HQ for each metal based on the surface soil EPC and soil screening level. The results are shown in Table 6-37. The following points are noteworthy:

- The HQs for antimony, barium, manganese, and mercury exceeded 1.
- The greatest HQs were for antimony (54) and mercury (2516), and a large percentage of site samples exceeded the screening levels for these analytes.
- The manganese HQ (1.7) at the RDM site is greater than 1; however, the EPC is less than the calculated background concentration (see Table 4-2 for surface soil background levels). This suggests that any potential risk to soil invertebrates from manganese at the RDM site is not related to historical use of the site for mining.
- The barium HQ (1.3) at the RDM site was only marginally greater than 1. Because of the conservative nature of the available soil screening levels for soil invertebrates, it seems unlikely that barium poses an actual risk to soil invertebrates at the RDM site.
- Arsenic, chromium, cobalt, silver, thallium, and vanadium were identified as COCs for the soil invertebrate community because they were detected in site surface soil, but no screening level was available. However, silver and thallium are unlikely to be of concern for the soil-invertebrate community at the site given their very low frequency of detection (two detects in 135 samples for both metals, see Table 6-37). Regarding chromium and vanadium, the surface soil EPCs at the site is the same as or less than the background levels in surface soil (compare Tables 6-37 and Table 4-2). Hence, any potential risks to the soil-invertebrate community at the site from chromium and vanadium are no different than background. Arsenic and cobalt were both detected in a large percentage of site samples (see Table 6-37), and the site surface soil EPCs exceeded the respective background levels, much more so for arsenic than cobalt (compare Tables 6-37 and Table 4-2).

In summary, it appears that antimony and mercury are the analytes with the greatest potential to adversely affect the soil invertebrate community at the RDM site. Arsenic may also be of concern for the soil invertebrate community given the factors discussed above.

#### 6.3.6.4 Benthic Macroinvertebrate Community Exposure Assessment and Risk Characterization

As noted in Table 6-36, three measures were used to evaluate potential risks to the benthic macroinvertebrate community at the site: (1) comparing sediment chemical concentrations to sediment screening levels; (2) benthic macroinvertebrate community survey in Red Devil Creek (BLM 2010); and (3) comparing chemical concentrations in surface water with chronic water criteria for protection of freshwater aquatic life.

### Comparing Sediment Chemical Concentrations with Sediment Screening Levels

The 15 metals identified in the SLERA as COPCs for the benthic macroinvertebrate community (see Section 6.3.3) are evaluated further in this section. COCs in sediment for this community were identified by calculating an HQ for each metal based on the sediment EPC and sediment screening level. The results are shown in Table 6-38. The following points are noteworthy:

- The HQs for antimony, arsenic, iron, manganese, mercury, and nickel exceeded 1.
- The greatest HQs were for antimony (990), arsenic (696), and mercury (34), and a large percentage of samples exceeded the screening levels for these analytes.
- The HQs for iron (2.4), manganese (2.7), and nickel (1.3) exceeded 1, but not excessively so. Given the generally conservative nature of the sediment screening levels, it seems unlikely that iron, manganese, and nickel pose a genuine threat to benthic macroinvertebrates at the site.
- Barium, beryllium, methylmercury, thallium, and vanadium were identified as COCs for the benthic macroinvertebrate community because they were detected in site sediment samples, but no screening level was available. Regarding vanadium, the sediment EPC at the site is less than the background sediment level (compare Table 6-38 with Tables 4-8 and 4-10). Hence, any potential risks to the benthic macroinvertebrate community at the site from vanadium are no greater than background. Barium, beryllium, methylmercury, and thallium were each detected in a large percentage of site samples and the site sediment EPC exceed the background sediment level (compare Table 6-38 with Tables 4-8 and 4-10).

In summary, based on comparisons with screening levels, it appears that antimony, arsenic, and mercury are the analytes with the greatest potential to adversely affect the benthic macroinvertebrate community at the RDM site. In addition, it is possible that barium, beryllium, methylmercury, and thallium may be COCs for the benthic macroinvertebrate community at the site, given the factors discussed above.

### Red Devil Creek Benthic Macroinvertebrate Survey

Preliminary results provided to E & E by the BLM identified no adverse impacts to abundance and diversity of benthic macroinvertebrates in Red Devil Creek compared with nearby reference creeks—Vreeland Creek, Ice Creek, California Creek, Downey Creek, No-Name Creek, Fuller Creek, and McCally Creek (personal communication with M. Varner, BLM, Anchorage, Alaska, 8 February 2012). Indeed, more intolerant taxa were found in Red Devil Creek than in any of the reference creeks sampled. These findings appear to be at odds with the results of the sediment screening level comparisons described above. Possible explanations for the presence of a healthy benthic community in Red Devil Creek despite high total concentrations of arsenic, antimony, and mercury in sediment include: (1) very little of the total concentrations of arsenic, antimony, and mercury is bioavailable and (2) the benthic macroinvertebrate community in Red Devil Creek has adapted to elevated levels of metals in creek sediments over time. A draft benthic community survey report is not yet available from the BLM. If it becomes available, the draft report will be included as an attachment to the final BERA.

#### Comparing Surface Water Chemical Concentrations with Surface Water Standards

Potential risks to benthic macroinvertebrates from chemicals in surface water are discussed in the following section.

### 6.3.6.5 Fish and Other Aquatic Biota Exposure Assessment and Risk Characterization

The six metals identified in the SLERA as COPCs for fish, benthic macroinvertebrates, amphibians, and other organisms exposed to surface water (see Section 6.3.3) are evaluated further in this section. COCs for these groups of organisms were identified by calculating a HQ for each metal based on the surface water EPC and chronic water quality criterion. The results are shown in Table 6-39. The following points are noteworthy.

- HQ values for antimony, arsenic, barium, iron, manganese, and mercury exceeded 1.
- Two HQs are presented for arsenic, iron, manganese based on EPCs calculated with and without the two water samples (10RD05SW and 11RD05DW) collected from the spring in the Main Processing Area. Arsenic, iron, and manganese concentrations in water from the spring are considerably greater than in Red Devil Creek and have a significant influence on the magnitude of the EPC for these three elements (see Table 6-39). Arsenic, iron, and manganese are not identified as COCs when the spring samples are omitted from consideration. The spring is located several feet above the creek's water level and to the side of the creek. Hence, the water samples from the spring are not creek surface water samples *per se*. The EPCs for arsenic, iron, and manganese calculated without the spring samples, but which do include creek samples collected at locations downstream of the spring's entry into the creek, may better reflect conditions in Red Devil Creek to which aquatic biota are exposed.
- The second greatest HQ is for barium (10.9); however, there is considerable uncertainty regarding the toxicity of barium to freshwater aquatic life. Suter and Tsao (1996) present a surface water screening level of 4 µg/L for barium (see Table 6-39). In contrast, the EPA (1986b) states that “the soluble barium concentration in fresh or marine water generally would have to exceed 50 mg/L before toxicity to aquatic life would be expected.” The difference between 4 µg/L and 50 mg/L is four orders of magnitude.
- The greatest HQ is for mercury; however, as noted in the SLERA, the mercury water quality criterion of 0.012 µg/L from the EPA (1986b) was developed from assumptions that are questionable for most surface water bodies. Specifically, this criterion is a Final Residue Value that was de-

rived from a bioconcentration factor of 81,700 for methylmercury with the fathead minnow and thus assumes that all mercury is present as methylmercury. Use of this criterion as a screening level for total mercury is highly conservative given that only a small fraction of total mercury in surface water is present as methylmercury (see Table 4-31).

In summary, six metals (antimony, arsenic, barium, iron, manganese, and mercury) were identified as COCs for fish and other aquatic organisms exposed to surface water in Red Devil Creek; however, it seems likely that the actual number of COCs is less than six given the factors discussed above.

#### 6.3.6.6 Fish Community Exposure Assessment and Risk Characterization

The 10 metals identified in the SLERA as COPCs for the fish community based on chemical residues in sculpin whole-body samples (see Section 6.3.3) are evaluated further in this section. COCs for the fish community were identified by calculating an HQ for each metal based on the whole-body sculpin EPC and fish tissue screening level. The results are shown in Table -40. The following points are noteworthy.

- The HQs for arsenic, mercury, methylmercury, and selenium exceeded 1.
- The greatest HQs were for arsenic (6.7) and mercury (4.7).
- Regarding selenium, the whole-body sculpin EPC at the site (1.9 mg/kg) lies within the concentration range for selenium in sculpin from nearby reference creeks. For example, in Vreeland Creek, for samples collected in June 2010, the observed range for selenium in whole-body sculpin samples was 0.84 to 2.5 mg/kg (personal communication with M. Varner, BLM, Anchorage, Alaska, 13 April 2011). Hence, any potential risk to fish in Red Devil Creek from selenium is little different than background.
- Antimony, barium, manganese, and vanadium were identified as COCs for fish because no fish tissue screening levels were identified for these analytes. However, the whole-body sculpin EPCs for barium (3.8 mg/kg), manganese (12.5 mg/kg), and vanadium (0.22 mg/kg) at Red Devil Creek lie with the concentration ranges for these metals observed in sculpin samples from nearby reference creeks. For example, in Vreeland Creek for samples collected in June 2010, the observed ranges for whole-body sculpin samples were 2.4 to 7.3 mg/kg for barium; 6.6 to 16.2 mg/kg for manganese; and 0.08 to 0.28 mg/kg for vanadium (personal communication with M. Varner, BLM, Anchorage, Alaska, 13 April 2011). Hence, any potential risks to fish in Red Devil Creek from barium, manganese, and vanadium are little different than background. Antimony levels in sculpin from Red Devil Creek are much greater than in nearby reference creeks (personal communication with M. Varner, BLM, Anchorage, Alaska, 13 April 2011).

In summary, it appears that arsenic, mercury, and methylmercury are the analytes with the greatest potential to adversely affect fish in Red Devil Creek. Antimony may also be of concern for fish in Red Devil Creek given the factors discussed above.

#### 6.3.6.7 Wildlife Exposure Assessment and Risk Characterization

A total of 17 metals were identified in the SLERA as COPCs for wildlife; up to 13 metals were identified as COPCs for any given species evaluated. These metals are further evaluated in this section. The wildlife risk evaluation was performed in accordance with state, federal, and other available guidance for ecological risk assessment, including ADEC (2011), EPA (1997, 1998), and Sample et al. (1996). The evaluation consists of three parts: (1) exposure assessment, (2) ecological effects assessment, and (3) risk characterization. The exposure assessment estimates wildlife exposure to site-related chemicals using measured concentrations of chemicals in environmental media and exposure parameters for the chosen receptor species. The ecological effects assessment summarizes the potential toxic effects of site-related chemicals on wildlife by establishing a toxicity reference value for each chemical for each receptor. The risk characterization combines the results of the exposure and ecological effects assessments to provide an estimate of risk to wildlife at the site.

##### 6.3.6.7.1 Wildlife Exposure Assessment

This section describes the data, receptors, and methods used to derive EPCs and exposure estimates for wildlife at the RDM site.

**Datasets Used to Calculate Exposure Estimates**

Analytical data for surface soil, sediment, surface water, and vegetation samples collected from the RDM site in 2010 and 2011 were used to calculate EPCs for these media. Full analytical results are presented earlier in this report for surface soil (Tables 4-17 to 4-23), surface water (Table 4-31), sediment (Tables 4 32 and 4-33), and vegetation (Table 4-34 to 4-37). A summary of the vegetation data is provided in Table 6-41. Also, metals data for benthic-macroinvertebrate and slimy-sculpin samples from Red Devil Creek collected by BLM in 2010 were used to evaluate exposures to aquatic-dependent wildlife; summaries of these data are provided in Table 6-42 and 6-43, respectively. Full analytical results for the fish and benthic macroinvertebrate samples were distributed by BLM in electronic form to E & E and other interested parties in April 2011; these data are not available in their entirety from the BLM in report form.

**Exposure Scenarios and Pathways**

Exposure estimates were calculated for the 11 wildlife receptors identified in the final RAWP and Table 6-36. These species are:

Herbivores:

- Spruce grouse (*Dendragapus canadensis*)
- Tundra vole (*Microtus oeconomus*)
- Beaver (*Castor canadensis*)
- Green-winged teal (*Anus crecca*)

Invertivores

- Common snipe (*Gallinago gallinag*)
- American robin (*Turdus migratorius*)
- Masked shrew (*Sorex cinereus*)

Carnivores
- Northern shrike (*Lanius excubitor*)
- Least weasel (*Mustela nivalis*)

Piscivores:
- Belted kingfisher (*Ceryle alcyon*)
- Mink (*Mustela vison*)

For these species, chemical exposure from diet, incidental ingestion of soil and/or sediment, and drinking was estimated. Exposure parameters for these wildlife species were taken from the final RAWP and are presented in Table 6-44.

### Exposure Point Concentrations

For most receptors, site-specific chemical concentrations in surface soil, sediment, surface water, and biota were used to calculate EPCs for these media (see Table 6-45). As described in Section 6.3.6.1, the UCL on the average concentration was used as the EPC, unless sample size was highly limited, in which case the maximum detected concentration was used as the EPC. Details are provided in Appendix G.

For terrestrial wildlife species that prey on soil invertebrates (e.g., earthworms) and small mammals, literature-based models were used to estimate chemical concentrations in prey. Surface soil EPCs were used as input to the models. EPCs for the 11 wildlife species evaluated in the BERA are presented in Tables 6-46 to 6-51. The models used to estimate chemical concentrations in earthworms and small mammals are provided in Tables 6-46 and 6-49.

### Wildlife Exposure Calculations

Chemical exposure for wildlife was calculated as the sum of exposures from diet, incidental soil/sediment ingestion, and drinking. Dietary exposure was calculated using the following equation:

$$EE_{diet} = ([(C_1 \text{ x } F_1) + (C_2 \text{ x } F_2) + \ldots (C_n \text{ x } F_n)] \text{ x } SUF \text{ x } ED \text{ x } IR)/BW$$

Where:

| | | |
|---|---|---|
| $EE_{diet}$ | = | Estimated exposure from diet (mg/kg-day) |
| $C_n$ | = | Chemical concentration in food item *n* (mg/kg, wet or dry weight) |
| $F_n$ | = | Fraction of diet represented by food item *n* |
| SUF | = | Site use factor (unitless) |
| ED | = | Exposure duration (unitless) |
| IR | = | Ingestion rate of receptor (kg, wet or dry weight/day) |
| BW | = | Body weight of receptor (kg) |

Food ingestion rates and body weights were taken from EPA (1993), Dunning (1993), or other credible references (see Table 6-44). The diet of each receptor was assumed to consist exclusively of its preferred prey (see Table 6.-44). For example, the diets of the American robin and marked shrew were assumed to consist entirely of soil invertebrates (e.g., earthworms). A wet food ingestion rate was used for the common snipe, kingfisher, and mink because chemical concentration data for benthic invertebrates and fish (sculpin) were provided on a wet weight basis. A dry food ingestion rate was used for all other receptors because site-specific data on chemical concentrations in their preferred food were provided on a dry weight basis (spruce needles, blueberry leaves, alder back, and pond vegetation) or because the models used to estimate chemical concentration in their preferred food yielded a dry weigh concentration (earthworms and small mammals).

The SUF indicates the portion (fraction) of an animal's home range represented by the site. If the home range is larger than the site, the SUF equals the site area divided by the home range area. If the site area is greater than or equal to the home range, the SUF equals 1. For all wildlife receptors except the green-winged teal, an SUF of 1 was deemed applicable given the size of the site relative to the home range size (see Table 6-44). For the teal, the SUF was set equal to 0.004. This value was determined by dividing the settling pond surface area (1 ha assumed) by the teal home range size (243 ha).

ED is the fraction of the year spent in the site area by the receptor species. The robin, shrike, snipe, teal, and kingfisher are migratory and were assumed to be present at the site for four months. An ED value of 0.33 (4/12) was used for these receptors (see Table 6-44). The other receptors evaluated were assumed to be present at the site year-round (ED = 1).

Home-range size, IR, diet composition, and BW for the wildlife species being evaluated, were taken from the EPA (1993), Dunning (1993), Kaufman (1996), or other credible references (see Table 6-44).

Wildlife exposure to chemicals through incidental soil/sediment ingestion was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{soil/sed} = (C_s \text{ x } IR_s \text{ x } SUF \text{ x } ED)/BW$$

Where:

| | | |
|---|---|---|
| $EE_{soil/sed}$ | = | Estimated exposure from incidental soil/sediment ingestion (mg/kg-day) |
| $C_s$ | = | Chemical concentration in soil/sediment (mg/kg, dry weight) |
| $IR_s$ | = | Soil/sediment ingestion rate of receptor (kg, dry weight/day) |

SUF, ED, and BW are as defined above.

Soil/sediment ingestion rates were taken from the literature (Beyer et al. 1994, 2008; Sample et al. 1997; Sample and Suter 1994); or based on professional judgment (if a literature value could not be found) (see Table 6-44).

Wildlife exposure to chemicals through drinking was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{drinking} = (C_w \text{ x } IR_w \text{ x } SUF \text{ x } ED)/BW$$

Where:

| | | |
|---|---|---|
| $EE_{drinking}$ | = | Estimated exposure from drinking surface water (mg/kg-day) |
| $C_w$ | = | Chemical concentration in surface water (mg/L) |
| $IR_s$ | = | Surface water ingestion rate (L/day) |

SUF, ED, and BW are as defined above.

Surface water ingestion rates were taken from the literature or calculated using allometric relationships from Sample et al. (1996). The values are provided in Table 6-44.

The total exposure for a receptor was calculated as the sum of the exposure from diet, incidental soil/sediment ingestion, and drinking as represented by the following equation:

$$EE_{total} = EE_{diet} + EE_{soil/sed} + EE_{\ drinking}$$

Where:

| | | |
|---|---|---|
| $EE_{total}$ | = | Total exposure (mg/kg-day) |
| $EE_{diet}$ | = | Estimated exposure from diet (mg/kg-day) |
| $EE_{soil/sed}$ | = | Estimated exposure from incidental soil/sediment ingestion (mg/kg-day) |
| $EE_{drinking}$ | = | Estimated exposure from surface water consumption (mg/kg-day) |

#### 6.3.6.7.2 Wildlife Ecological Effects Assessment

Mammalian and avian NOAELs and LOAELs were taken from the peer-reviewed literature. The values and sources are provided in Table 6-52.

#### 6.3.6.7.3 Wildlife Risk Characterization

**Risk Calculation Methodology**

The potential risks posed by site-related chemicals were determined by calculating an HQ for each contaminant for each wildlife endpoint species. The HQ was determined by dividing the total exposure ($EE_{total}$) by the NOAEL or LOAEL, as shown in the following equations:

$$HQ\text{-}NOAEL = EE_{total}/NOAEL$$

$$HQ\text{-}LOAEL = EE_{total}/LOAEL$$

For a given receptor and chemical, an HQ-NOAEL greater than 1 indicates that the estimated exposure exceeds the highest dose at which no adverse effect was observed. Such a result does not necessarily imply that the receptor is at risk, especially if the HQ-NOAEL is only marginally above 1. An HQ-LOAEL greater than 1 suggests that a chronic adverse effect is possible to an individual receptor, assuming that the estimated exposure for that receptor is accurate. Tables 6-53 to 6-63 present the estimated exposures and HQs for the 11 wildlife species evaluated.

### Risk Results

The following results are noteworthy:

- For the northern shrike, least weasel, and green-winged teal, no contaminants were predicted to pose a risk; however, quantitative risk estimates could not be calculated for all site-related contaminants due to a lack of toxicity reference values (see Tables 6-57, 6-58, and 6-61).
- For the American robin, arsenic and lead were predicted to pose a potential risk (see Table 6-53). It should be noted, however, that the potential lead risk is largely caused by a single surface soil sample (10MP48SS) with an unusually high total lead concentration (3090 mg/kg). The next highest lead concentration in surface soil is 220 mg/kg (sample 10MP27SS), and most surface soil sample results for lead are less than 30 mg/kg. If the EPC for lead in surface soil is calculated without the 3090 mg/kg value, the EPC is reduced by a factor of three, and no lead risks to the robin are predicted.
- For the masked shrew, nine contaminants were predicted to pose a potential risk (see Table 6-54). The greatest HQs were for antimony and arsenic. As discussed above for the robin, the potential risk to the shrew from lead appears to be an anomaly. Also, potential risks to the shrew from selenium and thallium seem highly unlikely given that both elements were detected in only 2 of 135 surface soil samples. For both contaminants, the maximum detected concentration was used to estimate exposure. This approach overestimates the true exposure.
- For the spruce grouse, arsenic, manganese, mercury, and vanadium were predicted to pose a risk (see Table 6-55). The greatest HQs were from arsenic and mercury.
- For the tundra vole, antimony, arsenic, and manganese were predicted to pose a risk (see Table 6-56). The greatest HQs were for antimony and arsenic. For these two contaminants, the estimated exposure from incidental soil ingestion accounts for greater than 99% of the total exposure. In contrast, for manganese, the estimated exposure from diet accounts for most of the total exposure.

- For the common snipe, arsenic, mercury, and selenium were predicted to pose a potential risk (see Table 6-57). The greatest HQ was for arsenic. Regarding selenium, it should be noted that the site sediment EPC (0.49 mg/kg, see Table 6-50) lies within the concentration range of selenium in Kuskokwim River background sediment samples (0.04 to 1.03 mg/kg, see Table 4-10). Hence, any potential risk to the snipe from selenium at the site is little different than background.
- For the beaver, only antimony was predicted to pose a risk (see Table 6-60). The estimated exposure from incidental soil ingestion accounted for 96% of the total exposure.
- For the belted-kingfisher, only selenium was predicted to pose a potential risk (see Table 6-62). The estimated exposure from diet (sculpin from Red Devil Creek assumed) accounted for greater than 99% of the total selenium exposure. As noted in Section 6.3.6.6, the whole-body sculpin EPC for selenium at the site (1.9 mg/kg) lies within the concentration range for selenium in sculpin from nearby reference creeks. Hence, any potential risk to kingfishers at the site from selenium is little different than background.
- For the mink, antimony, arsenic, methylmercury, and selenium were predicted to pose a risk (see Table 6-63). The greatest HQ was for antimony. The estimated exposure from diet (sculpin from Red Devil Creek assumed) accounted for greater than 99% of the total antimony exposure. Antimony levels in whole-body sculpin samples from Red Devil Creek are considerably greater than those in sculpin from nearby reference creeks (personnel communication with M. Varner, BLM, Anchorage, Alaska, 13 April 2011).

### 6.3.7 Uncertainties

Significant sources of uncertainty in the BERA include the following:

- **Bioavailability –** The bioavailability of chemicals in environmental media at the site is poorly understood. To be conservative, it was assumed that 100% of the chemicals in soil and sediment were bioavailable to all ecological receptors. If bioavailability is less than 100%, which seems likely, the potential risks to all categories of ecological receptors would be correspondingly lower. In general, uncertainties associated with bioavailability of metals in soil and sediment include: (1) lack of knowledge of how chemical, physical, and biological processes affect mobility (e.g., solubilization/precipitation and adsorption/desorption) and bioavailability of metals in soil and sediment; (2) lack of knowledge of how biota modify bioavailability of metals in soils and sediments in contact with external membranes (e.g., skin) or that are taken into the body (e.g., digestive tract); (3) lack of knowledge of whether bioavailability data for one species is applicable to bioavailability for other species; and (4) variability of chemical forms of metals in soil and sediment (e.g., redox state, mineralogy). The mercury SSE and SPLP data collected for the RI both suggest that much of the total metals content in soil and sediment is not mobile under the conditions expected to exist in site soil and sediment. Mercury SSE data indicate that only a small fraction of total mercury in site soil and sediment is water soluble (F1) or stomach acid soluble (F2) and that the proportion of these soluble fractions relative to the total mercury decreases with increasing total mercury concentration (see Section 5.2.2, Tables 4-17 to 4-23, and Tables 4-32 to 4-33). Similarly, SPLP data suggest that only a small fraction of the total arsenic, antimony, and mercury concentration in site soil samples is soluble under simulated field conditions (see Table 6-64).

- **Reliability of Soil Benchmarks –** Many of the available soil screening benchmarks for plants and soil invertebrates (i.e., earthworms) were developed from laboratory studies in which chemical solutions were added to clean soil to arrive at a range of test concentrations. In such studies, the added chemicals are highly bioavailable. Comparing total chemical concentrations in field samples to solution-based soil benchmarks is conservative and likely results in an overestimation of risk. For aluminum, the EPA (2003) has deemed that such a comparison is inappropriate.
- **Reliability of Sediment Screening Levels –** The available sediment screening levels are based on total concentrations without consideration of chemical bioavailability. The sediment screening levels used in the BERA are expected to be overly conservative predictors of adverse effects for benthic organisms in Red Devil Creek, given that a large fraction of many site-related contaminants likely occur largely in a form that is less than 100% bioavailable. As noted in Section 6.3.6.4, a benthic macroinvertebrate survey for Red Devil Creek found no adverse impacts on abundance and diversity of benthic macroinvertebrates in Red Devil Creek compared with nearby reference creeks. These results suggest that the literature-based sediment screening levels used in the BERA are not reliable predictors of effects in Red Devil Creek.
- **Availability of Media Screening Levels and Wildlife Toxicity Reference Values (TRVs) –** As indicated in Tables 6-37 to 6-39, screening levels are not available for all chemicals in all media. For example, reliable soil screening levels for the effects of antimony on plants and arsenic on soil invertebrates are not available. Hence, potential risks to plants from antimony and to soil invertebrates form arsenic could not be evaluated. Also, an avian TRV (i.e., NOAEL or LOAEL) is not available for antimony. Hence, potential risks to birds from antimony, which is one of the principal contaminants at the RDM site, could not be evaluated.
- **Chemicals in Wildlife Prey –** Food-chain transfer of contaminants at the site is poorly understood for terrestrial predatory wildlife (e.g., American robin, masked shrew, northern shrike, and least weasel). The potential risks to these species are driven in part by estimated concentrations of chemicals in prey. For this assessment, prey concentrations were estimated from measured soil and sediment concentrations using bioaccumulation factors and models from the literature. Or, if a literature-based bioaccumulation factor was not available, it was assumed that the prey concentration was the same as the soil or sediment concentration. The uncertainty associated with this approach often is high because a number of site-specific factors affect food-chain transfer of chemicals. In general, the bioaccumu-

lation factors and models used in this assessment are intended to provide a conservative estimate of chemicals in wildlife prey and are likely to result in an overestimation of risk.

- **Wildlife Diet –** Uncertainty may result from the assumptions made about the diets of the wildlife receptors evaluated in this assessment. For the shrew and robin, the assumption of a diet consisting entirely of earthworms is conservative. In addition to earthworms, shrews consume other invertebrates (i.e. slugs, snails, centipedes, and various insects), fungi, plant materials, and small mammals (EPA 1993). Similarly, robins also consume other invertebrates (i.e., spiders, sowbugs, and various insects) and plant materials (EPA 1993). These foods are less intimately associated with the soil matrix than earthworms and thus accumulate lesser amounts of soil contamination. The diet assumed for the shrew and robin in this assessment likely overestimates exposure and risks from chemicals in soil.
- **Wildlife Use of the RDM Site –** The wildlife evaluation assumed that all parts of the RDM site are equally attractive to wildlife, but this may not be the case. For example, wildlife may avoid the Main Processing Area because of its disturbed condition (i.e., compacted soils, sparse vegetation, etc.). Because the Main Processing Area is the most contaminated part of the site, wildlife exposure to site-related contaminants may have been overestimated if wildlife do not use the area, or do so only rarely.
- **Effect of Biased Sampling on Exposure Point Concentrations** – As discussed in Section 6.2.6.1, many soil and sediment samples collected for the RI were purposely collected from areas of known contamination (Main Processing Area, spring, Rice ore zone, Dolly ore zone, etc.). Samples collected in this manner provide information about the nature of contamination in areas heavily used during mining and ore processing, but are not statistically representative of the average concentration across the site to which wildlife are exposed. Inclusion of results from biased sampling leads to higher EPCs than would be expected from random exposure.
- **Uncertainty Regarding Pre-Mining Background Concentrations –** As discussed in Sections 6.2.6.1 and 4.1, it is likely that background contaminant levels in surface soil (see Table 4-2) have been underestimated at the RDM site. Consequently, the contribution of background to risk at the site likely has been underestimated.
- **Reliability of Surface Water Criteria –** In general, the EPA water quality criteria and State of Alaska water quality standards are considered to be among the most reliable screening levels because they are based on a large body of testing data and sound derivation methods. However, there are exceptions. For example, the mercury water quality criterion of 0.012 µg/L from the EPA (1986b) is a Final Residue Value that was derived from a bioconcentration factor of 81,700 for methylmercury with the fathead minnow, and thus assumes that all mercury is present as methylmercury. Use of this criterion as a screening level for total mercury is highly conservative given that only a small fraction of total mercury in surface water is present as methylmercury (see Table 4-31).

- **Reliability of Other Surface Water Screening Levels –** The EPA and State of Alaska water quality criteria are not available for all chemicals. For such chemicals, surface water screening levels from other sources were used (See Table 6-38). These other surface water screening levels are based on less testing data than federal and state water quality criteria, and therefore the level of uncertainty associated with them is greater.

- **Particulate versus Dissolved Contaminants in Red Devil Creek Surface Water –** Risks to aquatic biota from contaminants in surface water were evaluated in the BERA using unfiltered surface water sample results, which include both dissolved and particulate contaminant forms. For most contaminants, the dissolved form is a better indicator of the bioavailable form and commonly is a small fraction of the total concentration. For example, for mercury in Red Devil Creek surface water, typically less than 10% of the total concentration was dissolved (see Table 4-31).

### 6.3.8 Risk Summary

Table 6-65 provides a summary of the contaminants predicted to pose a potential risk to the assessment endpoints evaluated in the BERA. In general, the greatest HQ values were observed for antimony, arsenic, and mercury, as would be expected given the site history and local mineralogy. Additional observations to help interpret the significance of the risk results are presented below by assessment endpoint:

- For the terrestrial plant community, up to nine contaminants were predicted to be COCs (see Table 6-65). Confidence in the COC list and magnitude of the HQ values is considered low primarily because of the highly conservative nature of the soil screening levels for plants and because contaminant bioavailability in soil was not considered. If the HQ values for plants were adjusted to account for solubility of site contaminants (e.g., using the SPLP and mercury SSE results), the magnitude of the HQ values for antimony, arsenic, and mercury would be significantly lower. It should be noted that the Surface Mined Area has been successfully re-colonized by native plants since the end of mining at the site, suggesting that soil in this area is not phytotoxic. In contrast, the Main Processing Area has not been entirely re-colonized by native vegetation. While this situation could be the result of high levels of metals in soil, the highly compacted nature of the soil and/or absence of soil in some locations also are factors that may be limiting plant growth in the Main Processing Area.
- For the soil invertebrate community, up to 10 contaminants were predicted to be COCs (see Table 6-65). Confidence in the COC list and magnitude of the HQ values is considered low primarily because of the highly conservative nature of the screening levels for soil invertebrates and because contaminant bioavailability in soil was not considered. If the HQ values for soil invertebrates were adjusted to account for solubility of site contaminants (e.g., using the SPLP and mercury SSE results), the magnitude of the HQ values for antimony, arsenic, and mercury would be significantly lower.

- For fish, benthic macroinvertebrates, amphibians, and other aquatic organisms exposed to surface water, six COCs were identified (see Table 6-65). Confidence in the COC list and HQ values is considered low for the following reasons: (1) the evaluation in the BERA is based on total contaminant concentrations in unfiltered surface water samples (see Section 6.3.7); (2) the mercury water quality criterion on 0.012 µg/L is an older value based on the assumption that all mercury is in the form of methylmercury, which is not considered appropriate for the RDM site (see Section 6.3.7); and (3) no impacts to the benthic community of Red Devil Creek were apparent based on the benthic macroinvertebrate survey conducted by the BLM (see Section 6.3.6.4), suggesting that surface water in the creek is not toxic to aquatic life.
- For the fish community in Red Devil Creek, up to eight contaminants were predicted to be COCs based on comparing chemical concentration in whole-body sculpin samples with tissue screening concentrations (see Table 6-65). Confidence in the risk estimates is considered moderate to low depending on the contaminant. The range of tissue screening levels for methylmercury in fish (0.3 to 0.7 mg/kg wet weight) is fairly well known, given the extensive amount of research on methylmercury in fish (Sandheinrich and Wiener 2011). Tissue screening levels for other inorganic contaminants are less certain, and little data are available specifically for sculpin. Tissue screening levels were not identified for antimony, barium, manganese, and vanadium.
- For the benthic macroinvertebrate community, up to 11 contaminants were predicted to be COCs (see Table 6-31). Confidence in the COC list and HQ values based on this assessment method is considered low because site-specific bioavailability was not considered in the evaluation. Also, as noted above, a benthic macroinvertebrate survey conducted in Red Devil Creek identified no adverse impacts to abundance and diversity of benthic macroinvertebrates in Red Devil Creek compared with nearby reference creeks. The site-specific survey is considered to be a more reliable assessment method and suggests no impacts from site-related contaminants.
- For the terrestrial avian invertivore assessment endpoint, represented by the American robin, up to five contaminants (antimony, arsenic, beryllium, lead, and thallium) were identified as COCs (see Table 6-65). Confidence in the arsenic and lead risk estimates is considered low for three reasons: (1) site-specific contaminant bioavailability in soil was not quantitatively considered; (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms); and (3) the lead exposure for the robin likely was overestimated (see Section 6.3.6.7.3). Regarding beryllium and thallium, it seems unlikely that these are COCs for the robin because the levels of these contaminants in surface soil at the site and background are similar (compare Tables 6-46 and 4-2). Potential risks from antimony cannot be ruled out.
- For the terrestrial mammalian invertivore assessment endpoint, represented by the masked shrew, eight COCs were identified (see Table 6-65). Confidence in the risk estimates is considered low for three reasons: (1)

site-specific contaminant bioavailability in soil was not quantitatively considered; (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms); and (3) the lead, thallium, and selenium exposures for this receptor likely were overestimated (see Section 6.3.6.7.3).

- For the terrestrial avian herbivore assessment endpoint, represented by the spruce grouse, up to six contaminants (antimony, arsenic, beryllium, mercury, thallium, and vanadium) were predicted to be COCs (see Table 6-65). Confidence in the arsenic and mercury risk estimates is considered moderate. Although contaminant levels in the primary food of the spruce grouse (spruce needles) was measured, site-specific contaminant bioavailability in soil was not quantitatively considered. It seems unlikely that beryllium, thallium, and vanadium are COCs for this receptor given that their concentrations in site and background surface soil are similar (compare Tables 6-47 and 4-2). Potential risks from antimony cannot be ruled out.
- For the terrestrial mammalian herbivore assessment endpoint, represented by the tundra vole, antimony, arsenic, and manganese were identified as COCs (see Table 6-65). Confidence in the risk estimates is considered moderate. Although contaminant levels in a representative forage plant (blueberry stems/leaves) were measured and used to quantify vole dietary exposure, site-specific contaminant bioavailability in soil was not quantitatively considered.
- For the terrestrial carnivorous bird assessment endpoint, represented by the northern shrike, no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated (see Table 6-65). It seems unlikely that beryllium and thallium are COCs for this receptor because the levels of these contaminants in surface soil at the RDM site and background are similar (compare Tables 6-49 and 4-2). Potential risks from antimony cannot be ruled out.
- For the terrestrial carnivorous mammal assessment endpoint, represented by the least weasel, no COCs were identified (see Table 6-65).
- For the semi-aquatic avian invertivore assessment endpoint, represented by the common snipe, up to five COCs (antimony, arsenic, beryllium, selenium, and thallium) were identified (see Table 6-65). It seems unlikely that beryllium, selenium, and thallium are COCs for this receptor because the levels of these contaminants in site and background sediment are similar (compare Tables 6-50 and 4-10). Confidence in the arsenic risk estimate for the snipe is considered moderate. Although the arsenic level in snipe prey (benthic macroinvertebrates from Red Devil Creek) was measured, site-specific arsenic bioavailability in sediment was not quantitatively considered. Potential risks to the snipe from antimony could not be quantitatively evaluated and cannot be ruled out.
- For the semi-aquatic mammalian herbivore assessment endpoint, represented by the beaver, arsenic was identified as a COC (see Table 6-65). Confidence in the arsenic risk estimate for the beaver is considered moderate. Although the arsenic level in a representative food of the beaver (al-

der bark) was measured, site-specific arsenic bioavailability in soil was not quantitatively considered.

- For the semi-aquatic avian herbivore assessment endpoint, represented by the green-winged teal, no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated (see Table 6-65). It seems unlikely that beryllium and thallium are COCs for this receptor because the levels of these contaminants in settling pond sediment and background sediment are similar (compare Tables 6-48 and 4-10). Potential risks from antimony cannot be ruled out, but seem unlikely given the site use and exposure duration considerations discussed above (see Section 6.3.6.7.1).
- For the avian piscivore assessment endpoint, represented by the belted kingfisher, no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated (see Table 6-65). It seems unlikely that beryllium and thallium are COCs for this receptor because the levels of these contaminants in site and background sediment are similar (compare Tables 6-51 and 4-10). Potential risks from antimony cannot be ruled out.
- For the mammalian piscivore assessment endpoint, represented by the mink, antimony, arsenic and selenium were identified as COCs (see Table 6.-65). For the BERA, it was assumed that mink prey on sculpin from Red Devil Creek. As noted in Section 6.3.6.6, the whole-body sculpin EPC for selenium at the site (1.9 mg/kg) lies with the concentration range for selenium in sculpin from nearby reference creeks. Hence, any potential risks to mink at the site from selenium are little different than background. Confidence in the antimony and arsenic risk estimates for the mink are considered moderate to high.

Several data gaps were identified during the development of the BERA. Chief among these are:

- Contaminant levels in terrestrial invertebrates, the assumed prey of the masked shrew and American robin, are poorly understood at the site. For the BERA, literature models were used to estimate contaminant levels in terrestrial invertebrates or, if no model was available, the terrestrial invertebrate contaminant concentration was assumed to be equal to the soil contaminant concentration. The latter approach was used for antimony and is the reason that the antimony HQ value (2478) for the shrew is so high (see Tables 6-46 and 6-54).
- Site-specific bioavailability of contaminants in soil to plants, soil invertebrates, and wildlife is not well understood but is expected to be limited based on mercury SSE and SPLP data collected for the RI, which indicate that antimony, arsenic, and mercury forms in soil at the site are only sparingly soluble.

## 6.4 Development of Risk-Based Cleanup Levels

### 6.4.1 Human Health Risk-Based Cleanup Levels

Preliminary alternative risk-based cleanup levels (RBCLs) are developed in the HHRA for COCs (COPCs that exceed risk-based standards). Developing RBCLs for each scenario provides a range of RBCLs based on future land use and will assist in risk management decisions at the site, including determination of remedial action objectives (RAOs).

Preliminary RBCLs were developed for each scenario and COC that exceeds a target cancer risk of 1 in 100,000 ($10^{-5}$) and an HI of 1.0. COCs by media are included in Table 6-66:

RBCLs were developed using the exposure equations and parameters identified in the HHRA and back-calculating a target concentration in each individual medium. Arsenic is the only carcinogen that was identified as a COC; RBCLs for arsenic were calculated using a ratio approach targeting a cancer risk of 1 in 100,000. Although arsenic presents noncarcinogenic hazards, the RBCL for carcinogenic risks is lower than that for noncarcinogenic hazards. Noncarcinogenic COC RBCLs were calculated using a ratio approach targeting an HQ = 1.0. RBCLs are provided in Table 6-67, by medium. Although RBCLs from groundwater ingestion were calculated for the mine worker exposure scenarios, ADEC guidance indicates that RBCLs for groundwater should not be based on such scenarios. These values are shown for comparison only.

Consumption of wild food also poses a risk to potential future residents and, to a lesser extent, recreational/subsistence users and mine workers. Final RAOs should be adjusted to ensure that the cumulative risk and hazard at the site do not exceed a target excess cancer risk of 1 in 100,000 ($10^{-5}$) or an HI of 1.0.

Lead was not determined to be a COC in soil at the site, so no RBCL is needed for lead.

Generally, cleanup levels are not set at concentrations below natural background levels. If RBCLs exceed background levels, preliminary cleanup levels should default to background concentrations.

### 6.4.2 Preliminary Ecological Risk Based Cleanup Levels

In light of the importance of arsenic, antimony, and mercury in driving ecological (and human health) risks at the site, this section is focused on preliminary cleanup levels for arsenic, antimony, and mercury for protection of ecological receptors. Preliminary cleanup levels for surface soil, sediment, and surface water are presented in Tables 6-68 to 6-70 for arsenic, antimony, and mercury, respectively along with a discussion of the methods used to derive them and their reliability. As noted in Section 6.4.1, cleanup levels are not set at concentrations below natural background levels. If risk-based levels are less than background, the cleanup level should default to the background concentration.

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## 6.6 Acronyms Used in Chapter 6

| | |
|---|---|
| (µg Pb/dL | micrograms of lead per deciliter |
| °C | degrees centigrade |
| °F | degrees Fahrenheit |
| $(mg/kg\text{-}day)^{-1}$ | risk per milligram per kilogram per day |
| $(\mu g/m^3)^{-1}$ | risk per microgram per cubic meter |
| $ABS_{dermal}$ | dermal absorption |
| ADEC | Alaska Department of Environmental Conservation |
| ADF&G | Alaska Department of Fish and Game |
| AF | adherence factor |
| AT | averaging time |
| ATV | All-terrain vehicle |
| BERA | Baseline ecological risk assessment |
| BLM | U. S. Department of the Interior Bureau of Land Management |
| BMD | benchmark dose |
| BMI | Body mass index |
| BW | body weight |
| cm | centimeter |
| $cm^2$ | square centimeters |
| $C_n$ | chemical concentration in food item *n* |
| COCs | compounds of concern |
| COPC | contaminants of potential concern |
| CSIS | Community Subsistence Information System |
| CSM | conceptual site model |
| DA | Red Devil Creek Downstream Alluvial Area (exposure unit) |
| DBH | diameter at breast height |
| E & E | Ecology and Environment, Inc. |
| EC | exposure concentration |
| ED | exposure duration |
| $EE_{diet}$ | estimated exposure from diet |
| EER | Estimated energy requirements |
| $EE_{soil/sed}$ | estimated exposure from incidental soil/sediment ingestion |
| $EE_{total}$ | total exposure |
| EF | exposure frequency |
| ELCR | Excess lifetime cancer risk |
| EPA | U.S. Environmental Protection Agency |
| EPC | exposure point concentration |
| ERA | Ecological Risk Assessment |
| ERAGS | United States Environmental Protection Agency Ecological Risk Assessment Guidance for Superfund |
| FCM | food chain multiplier |
| $FeS_2$ | Pyrite |
| FI | fraction ingested |
| $F_n$ | fraction of diet represented by food item *n* |
| FS | Feasibility Study |
| FW | fresh weight |

| | |
|---|---|
| g/m$^2$-s per kg/m$^3$ | grams per square meter per second, per kilograms per cubic meter |
| GI | gastrointestinal |
| HA | hectare |
| HEAST | [EPA Superfund] Health Effects Assessment Summary Tables |
| HgS | cinnabar |
| HHRA | Human Health Risk Assessment |
| HI | hazard index |
| HQ | hazard quotient |
| IEUBK | Integrated Exposure Uptake Biokinetic |
| IR | ingestion rate of receptor |
| $IR_s$ | soil/sediment ingestion rate of receptor |
| IUR | inhalation unit risk |
| kg | kilogram[s] |
| km | kilometer |
| L/day | liters per day |
| LADI | lifetime average daily intake |
| LEL | low effect level |
| LOAEL | lowest observed adverse effect level |
| LPAH | Low molecular weight polycyclic aromatic hydrocarbons |
| m/s | meters per second |
| MCLs | maximum contaminant levels |
| mg | milligram(s) |
| mg/day | milligrams per day |
| mg/kg | milligrams per kilogram |
| mg/kg-day | milligrams per kilogram per day |
| mg/L | Milligrams per liter |
| mg/m$^3$ | milligrams per cubic meter |
| MPA | Main Processing Area (exposure unit) |
| NDs | nondetected values |
| NOAEL | no observed adverse effect level |
| ORNL | Oak Ridge National Laboratory |
| PAH | Polycyclic aromatic hydrocarbons |
| PEF | particulate emission factor |
| RAGS | Risk Assessment Guidance for Superfund |
| RAO | remedial action objective |
| RAWP | Risk Assessment Work Plan |
| RBCLs | risk-based cleanup levels |
| RBSCs | risk-based screening concentrations |
| RDM | Red Devil Mine |
| RfC | reference concentration |
| RfD | reference dose |
| RI | Remedial Investigation |
| RME | reasonable maximum exposure |
| ROS | regression on order statistics |
| RSLs | Regional Screening Levels |
| SA | skin surface area |

| | |
|---|---|
| $Sb_2S_3$ | stibnite |
| SF | slope factor |
| SLERA | screening level ecological risk assessment |
| SMA | Surface Mined Area (exposure unit) |
| SSE | selective sequential extraction |
| SUF | site use factor |
| SVOCs | semivolatile organic compounds |
| TRV | toxicity reference value |
| TWA | Time-weighted average |
| UCL | upper confidence limit |
| USGS | U.S. Geological Survey |
| WOE | Weight-of-evidence |
| YKHC | Yukon-Kuskokwim Health Corporation |
| µg/dL | micrograms per deciliter |
| µg/L | micrograms per liter |
| $\mu g/m^3$ | micrograms per cubic meter |

# Tables

**Table 6.1 Surface Soil (0 to 2 feet) Human Health Screening Results, Red Devil Mine Site.**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | Frequency of Detection | Soil Human Health Screening Levels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | EPA RSL - Residential | ADEC - Direct Contact | ADEC - Outdoor Inhalation | BLM - Human RMC | COPC | Rationale[c] |
| **Metals (mg/kg)** | | | | | | | | | | |
| Aluminum | 135 | 2410 | 21700 | 135/135 | 7.70E+03 | -- | -- | -- | YES | >SL |
| Antimony | 135 | 0.708 J | 23300 J | 111/135 | 3.1 | 4.1 | -- | 3 | YES | >SL |
| Arsenic | 136 | 9 | 9880 | 134/136 | 0.039 | 0.45 | -- | 1 | YES | >SL |
| Inorganic Arsenic | 35 | 24.9 J | 20100 | 35/35 | 0.039 | 0.45 | -- | 1 | YES | >SL |
| Barium | 135 | 76.2 | 1710 | 135/135 | 1.50E+03 | 2030 | -- | -- | YES | >SL |
| Beryllium | 135 | 0.3 | 1.3 | 132/135 | 16 | 20 | -- | -- | NO | <SLs |
| Cadmium | 135 | 0.18 | 1.3 | 38/135 | 7 | 7.9 | -- | 3 | NO | <SLs |
| Calcium | 135 | 390 | 10400 J | 135/135 | -- | -- | -- | -- | NO | NUT |
| Chromium[d] | 135 | 6 | 101 | 135/135 | 2.90E-01 | 30 | -- | -- | YES | >SL |
| Cobalt | 135 | 5.9 | 38.8 | 135/135 | 2.3 | -- | -- | -- | YES | >SL |
| Copper | 135 | 17 | 139 | 135/135 | 3.10E+02 | 410.0 | -- | 250 | NO | <SLs |
| Iron | 135 | 16800 | 59100 | 135/135 | 5.50E+03 | -- | -- | -- | YES | >SL |
| Lead | 135 | 5 | 3090 | 126/135 | 400 | 40 | -- | 400 | YES | >SL |
| Magnesium | 135 | 390 | 11400 | 135/135 | -- | -- | -- | -- | NO | NUT |
| Manganese | 135 | 153 | 4230 | 135/135 | 1.80E+02 | -- | -- | 960 | YES | >SL |
| Mercury[e] | 135 | 0.05 J | 1620 | 135/135 | 1 | 3 | 2 | 2 | YES | >SL |
| Nickel | 135 | 18 | 97 | 135/135 | 1.50E+02 | 200 | -- | 135 | NO | <SLs |
| Potassium | 135 | 600 | 4720 | 135/135 | -- | -- | -- | -- | NO | NUT |
| Selenium | 135 | 0.24 | 0.42 | 2/135 | 3.90E+01 | 51 | -- | 35 | NO | <SLs |
| Silver | 135 | 0.068 | 0.123 | 2/135 | 3.90E+01 | 51 | -- | 35 | NO | <SLs |
| Sodium | 135 | 42.3 | 430 | 75/135 | -- | -- | -- | -- | NO | NUT |
| Thallium | 135 | 0.065 | 0.071 | 2/135 | 0.078 | 0.81 | -- | -- | NO | <SLs |
| Vanadium | 135 | 15.3 | 51.9 | 135/135 | 3.90E+01 | 71 | -- | -- | YES | >SL |
| Zinc | 135 | 38 | 386 | 135/135 | 2.30E+03 | 3040 | -- | 2000 | NO | <SLs |
| **Polychlorinated Biphenyls (PCBs) (mg/kg)** | | | | | | | | | | |
| Aroclor-1260 | 18 | 0.021 J | 0.021 J | 1/18 | 0.22 | 0.1 | -- | -- | NO | <SLs |
| **Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)** | | | | | | | | | | |
| 1-Methylnaphthalene | 11 | 15 J | 74 | 4/11 | 22,000 | 28000 | 76000 | -- | NO | <SLs |
| 2-Methylnaphthalene | 12 | 29 | 200 | 5/12 | 31,000 | 28000 | 75000 | -- | NO | <SLs |
| Acenaphthene | 12 | 2.3 J | 2.3 J | 1/12 | 340,000 | 280000 | -- | -- | NO | <SLs |
| Acenaphthylene | 12 | 1.3 J | 1.3 J | 1/12 | -- | 280000 | -- | -- | NO | <SLs |
| Anthracene | 12 | 2 J | 2 J | 1/12 | 1,700,000 | 2060000 | -- | -- | NO | <SLs |
| Benzo(b)fluoranthene | 12 | 10 J | 10 J | 1/12 | 150 | 490 | -- | -- | NO | <SLs |
| Benzo(k)fluoranthene | 12 | 10 J | 10.0 J | 1/12 | 1,500 | 4900 | -- | -- | NO | <SLs |
| Fluorene | 12 | 2.5 J | 20 | 2/12 | 230,000 | 230000 | -- | -- | NO | <SLs |
| Naphthalene | 12 | 14 J | 70 | 3/12 | 3,600 | 140000 | 2800 | -- | NO | <SLs |
| Phenanthrene | 12 | 4.2 J | 48 | 4/12 | -- | 2060000 | -- | -- | NO | <SLs |
| Pyrene | 12 | 2.8 J | 2.8 J | 1/12 | 170,000 | 140000 | -- | -- | NO | <SLs |
| **Other Semivolatile Organic Compounds (SVOCs) (µg/kg)** | | | | | | | | | | |
| 4-Bromophenyl Phenyl Ether | 12 | 1.9 J | 1.9 J | 1/12 | -- | -- | -- | -- | YES | NS |
| 4-Methylphenol | 12 | 4.9 J | 4.9 J | 1/12 | -- | 35000 | -- | -- | NO | <SLs |

**Table 6.1 Surface Soil (0 to 2 feet) Human Health Screening Results, Red Devil Mine Site.**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | | Maximum Detected Concentration | | Frequency of Detection | Soil Human Health Screening Levels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | EPA RSL - Residential | ADEC - Direct Contact | ADEC - Outdoor Inhalation | BLM - Human RMC | COPC | Rationale[c] |
| Benzoic Acid | 12 | 120 | J | 120 | J | 1/12 | 2.40E+07 | 31700000 | -- | -- | NO | <SLs |
| Benzyl Alcohol | 12 | 12 | J | 12 | J | 1/12 | 6.10E+05 | -- | -- | -- | NO | <SLs |
| Bis(2-Ethylhexyl)phthalate | 12 | 11 | J | 220 | | 8/12 | 35000 | 22000 | -- | -- | NO | <SLs |
| Dibenzofuran | 12 | 2.4 | J | 10 | J | 2/12 | 7800 | 20000 | -- | -- | NO | <SLs |
| Diethylphthalate | 12 | 8 | | 140 | B | 2/12 | 4,900,000 | 6190000 | -- | -- | NO | <SLs |
| Dimethylphthalate | 12 | 160 | | 160 | | 1/12 | -- | 77300000 | -- | -- | NO | <SLs |
| Hexachlorobenzene | 12 | 1.3 | J | 1.3 | J | 1/12 | 300.0 | 320 | 150 | -- | NO | <SLs |
| Pentachlorophenol | 12 | 38 | J | 38 | J | 1/12 | 890.00 | 3900.0 | -- | -- | NO | <SLs |
| Phenol | 12 | 4.6 | J | 4.6 | J | 1/12 | 1,800,000 | 2320000 | -- | -- | NO | <SLs |

Key:
-- = not available or not applicable
µg/kg = micrograms per kilogram
BLM = Bureau of Land Management
COPC = chemical of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
PCBs = polychlorinated biphenyls
RMC = risk management criteria
RSL = regional screening level
SVOCs = semivolatile organic compounds
Shading = Chemical is a selected as a COPC.

Notes:
a = Detected chemicals only are listed.
b = For metals, 127 original site samples and 8 field duplicate samples. For PCB, 16 original site samples and 2 field duplicates. For PAHs and SVOCs, 11 original site samples and 1 field duplicate.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = For conservative screening criteria, hexavalent chromium values for used.
e = RSL based on elemental mercury.

Table 6-2 Subsrface Soil (2 to 15 feet) Human Health Screening Results, Red Devil Mine Site.

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | Frequency of Detection | Soil Human Health Screening Levels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | EPA RSL - Residential | ADEC - Direct Contact | ADEC - Outdoor Inhalation | BLM - Human RMC | COPC | Rationale[c] |
| **Metals (mg/kg)** | | | | | | | | | | |
| Aluminum | 192 | 1530 | 16800 | 192/192 | 7.70E+03 | -- | -- | -- | YES | >SL |
| Antimony | 192 | 0.19 J | 28900 J | 192/192 | 3.1 | 4.1 | -- | 3 | YES | >SL |
| Arsenic | 249 | 3.36 J | 9530 | 249/249 | 0.039 | 0.45 | -- | 1 | YES | >SL |
| Inorganic Arsenic | 12 | 10.7 | 7840 | 12/12 | 0.039 | 0.45 | -- | 1 | YES | >SL |
| Barium | 192 | 61.1 | 1050 | 192/192 | 1.50E+03 | 2030 | -- | -- | NO | <SLs |
| Beryllium | 192 | 0.187 | 0.981 | 192/192 | 16 | 20 | -- | -- | NO | <SLs |
| Cadmium | 192 | 0.132 J | 1.22 J | 192/192 | 7 | 7.9 | -- | 3 | NO | <SLs |
| Calcium | 192 | 768 J | 117000 J | 192/192 | -- | -- | -- | -- | NO | NUT |
| Chromium[d] | 192 | 8.18 J | 59.6 J | 192/192 | 2.90E-01 | 30 | -- | -- | YES | >SL |
| Cobalt | 192 | 5.5 | 34.4 | 192/192 | 2.3 | -- | -- | -- | YES | >SL |
| Copper | 192 | 14.2 J | 139 J | 192/192 | 3.10E+02 | 410.0 | -- | 250 | NO | <SLs |
| Iron | 192 | 14800 | 96500 | 192/192 | 5.50E+03 | -- | -- | -- | YES | >SL |
| Lead | 192 | 0.027 J | 396 | 192/192 | 400 | 40 | -- | 400 | YES | >SL |
| Magnesium | 192 | 316 J | 11300 | 192/192 | -- | -- | -- | -- | NO | NUT |
| Manganese | 192 | 102 | 2170 | 191/192 | 1.80E+02 | -- | -- | 960 | YES | >SL |
| Mercury[e] | 192 | 0.137 | 6110 J | 192/192 | 1 | 3 | 2 | 2 | YES | >SL |
| Nickel | 192 | 16.5 | 99.1 | 192/192 | 1.50E+02 | 200 | -- | 135 | NO | <SLs |
| Potassium | 192 | 586 | 4580 J | 192/192 | -- | -- | -- | -- | NO | NUT |
| Selenium | 192 | 0.04 J | 6.07 | 192/192 | 3.90E+01 | 51 | -- | 35 | NO | <SLs |
| Silver | 192 | 0.033 | 0.554 J | 192/192 | 3.90E+01 | 51 | -- | 35 | NO | <SLs |
| Sodium | 192 | 21.3 | 876 J | 192/192 | -- | -- | -- | -- | NO | NUT |
| Thallium | 192 | 0.051 | 1.54 | 192/192 | 0.078 | 0.81 | -- | -- | YES | >SL |
| Vanadium | 192 | 14.2 | 44.6 J | 192/192 | 3.90E+01 | 71 | -- | -- | YES | >SL |
| Zinc | 192 | 39.8 J | 461 J | 192/192 | 2.30E+03 | 3040 | -- | 2000 | NO | <SLs |
| **Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)** | | | | | | | | | | |
| 2-Methylnaphthalene | 13 | 12 | 1900 | 5/9 | 31,000 | 28000 | 75000 | -- | NO | <SLs |
| Acenaphthene | 13 | 270 J | 410 | 4/13 | 340,000 | 280000 | -- | -- | NO | <SLs |
| Benzo(a)pyrene | 13 | 9.4 J | 9.4 J | 1/13 | 15 | 490 | | -- | NO | <SLs |
| Benzo(b)fluoranthene | 13 | 1.3 J | 7.2 J | 3/13 | 150 | 4900 | -- | -- | NO | <SLs |
| Benzo(g,h,i)perylene | 13 | 10 J | 10 J | 1/13 | -- | 1400000 | -- | -- | NO | <SLs |
| Benzo(k)fluoranthene | 13 | 3.7 J | 3.7 J | 1/13 | 1,500 | 4900 | -- | -- | NO | <SLs |
| Chrysene | 13 | 2.9 J | 4.4 J | 3/13 | 15,000 | 490000 | | -- | NO | <SLs |
| Dibenz(a,h)anthracene | 13 | 7.8 J | 7.8 J | 1/13 | 15 | 490 | -- | -- | NO | <SLs |
| Fluorene | 13 | 1.7 J | 1400 | 9/13 | 230,000 | 230000 | -- | -- | NO | <SLs |
| Indeno(1,2,3-cd)pyrene | 13 | 11 J | 11 J | 1/13 | 150 | 4900 | -- | -- | NO | <SLs |
| Naphthalene | 13 | 8.3 | 3500 | 7/13 | 3,600 | 140000 | 2800 | -- | YES | <SLs |
| Phenanthrene | 13 | 1.9 J | 1100 | 11/13 | -- | 2060000 | -- | -- | NO | <SLs |
| Pyrene | 13 | 1.7 J | 1.8 J | 2/13 | 170,000 | 140000 | -- | -- | NO | <SLs |
| **Other Semivolatile Organic Compounds (SVOCs) (µg/kg)** | | | | | | | | | | |
| 4-Cholroaniline | 13 | 8 | 8 | 1/13 | 2400 | 90000 | -- | -- | NO | <SLs |

**Table 6-2 Subsrface Soil (2 to 15 feet) Human Health Screening Results, Red Devil Mine Site.**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | | Maximum Detected Concentration | | Frequency of Detection | Soil Human Health Screening Levels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | EPA RSL - Residential | ADEC - Direct Contact | ADEC - Outdoor Inhalation | BLM - Human RMC | COPC | Rationale[c] |
| Benzyl Alcohol | 13 | 11 | J | 11 | J | 1/13 | 6.10E+05 | -- | -- | -- | NO | <SLs |
| Bis(2-Ethylhexyl)phthalate | 13 | 10 | J | 10 | J | 1/13 | 35000 | 22000 | -- | -- | NO | <SLs |
| Dibenzofuran | 13 | 18 | J | 57 | J | 2/13 | 7800 | 20000 | -- | -- | NO | <SLs |
| Diethylphthalate | 13 | 1.7 | J | 1.7 | J | 1/13 | 4,900,000 | 6190000 | -- | -- | NO | <SLs |
| N-Nitrosodiphenylamine | 13 | 1.8 | J | 1.8 | J | 1/13 | 9,900 | 750000 | -- | -- | NO | <SLs |

Key:
-- = not available or not applicable
µg/kg = micrograms per kilogram
ADEC = Alaska Department of Environmental Conservation
BLM = Bureau of Land Management
COPC = chemical of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
RMC = risk management criteria
RSL = regional screening level
SVOCs = semivolatile organic compounds
Shading = Chemical is a selected as a COPC.

a = Detected chemicals only are listed.
b =
For metals, 170 original site samples and 22 field duplicate samples. For PAHs and SVOCs, 11 original site samples and 2 field duplicates.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = For conservative screening criteria, hexavalent chromium values for used.
e = RSL based on elemental mercury.

## Table 6-3 Sediment Human Health Screening Results for Red Devil Creek and Kuskokwim River Sediment, Red Devil Mine Site.

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | Frequency of Detection | Soil Human Health Screening Levels | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | EPA RSL - Residential | ADEC - Direct Contact | ADEC - Outdoor Inhalation | BLM - Human RMC | BLM - Camper RMC | COPC | Rationale[c] |
| **Metals (mg/kg)** | | | | | | | | | | | |
| Aluminum | 45 | 710 | 18400 | 45/45 | 7.70E+03 | -- | -- | -- | -- | YES | >SL |
| Antimony | 45 | 0.237 J | 6360 J | 40/45 | 3.1 | 4.1 | -- | 3 | 62 | YES | >SL |
| Arsenic | 50 | 0.57 J | 130000 | 50/50 | 0.039 | 0.45 | -- | 1 | 46 | YES | >SL |
| Inorganic Arsenic | 24 | 24.7 J | 188000 J | 24/24 | 0.039 | 0.45 | -- | 1 | 46 | YES | >SL |
| Barium | 45 | 4.12 | 1990 | 45/45 | 1.50E+03 | 2030 | -- | -- | -- | YES | >SL |
| Beryllium | 45 | 0.008 J | 0.9 | 43/45 | 16 | 20 | -- | -- | -- | NO | <SLs |
| Cadmium | 45 | 0.017 J | 0.663 J | 32/45 | 7 | 7.9 | -- | 3 | 155 | NO | <SLs |
| Calcium | 45 | 1320 | 26300 | 45/45 | -- | -- | -- | -- | -- | NO | NUT |
| Chromium[d] | 45 | 0.65 J | 47.4 J | 43/45 | 2.90E-01 | 30 | -- | -- | -- | YES | >SL |
| Cobalt | 45 | 0.369 | 50 | 45/45 | 2.3 | -- | -- | -- | -- | YES | >SL |
| Copper | 45 | 0.68 | 87.5 | 45/45 | 3.10E+02 | 410.0 | -- | 250 | 5745 | NO | <SLs |
| Iron | 45 | 19600 | 344000 | 45/45 | 5.50E+03 | -- | -- | -- | -- | YES | >SL |
| Lead | 45 | 0.05 | 14.8 | 43/45 | 400 | 40 | -- | 400 | 1000 | NO | <SLs |
| Magnesium | 45 | 990 | 11400 J | 45/45 | -- | -- | -- | -- | -- | NO | NUT |
| Manganese | 45 | 404 | 5410 | 45/45 | 1.80E+02 | -- | -- | 960 | 21679 | YES | >SL |
| Mercury[e] | 45 | 0.169 J | 119 J | 45/45 | 1 | 3 | 2 | 2 | 46 | YES | >SL |
| Methylmercury | 33 | 0.0001 J | 0.0144 | 32/33 | 0.78 | 0.77 | - | - | - | NO | <SLs |
| Nickel | 45 | 0.78 | 240 J | 45/45 | 1.50E+02 | 200 | -- | 135 | 3094 | YES | >SL |
| Potassium | 45 | 510 J | 2870 J | 43/45 | -- | -- | -- | -- | -- | NO | NUT |
| Selenium | 45 | 0.16 J | 2.11 | 28/45 | 3.90E+01 | 51 | -- | 35 | 774 | NO | <SLs |
| Silver | 45 | 0.04 | 0.41 | 29/45 | 3.90E+01 | 51 | -- | 35 | 774 | NO | <SLs |
| Sodium | 45 | 21.1 | 270 | 39/45 | -- | -- | -- | -- | -- | NO | NUT |
| Thallium | 45 | 0.011 J | 0.653 | 29/45 | 0.078 | 0.81 | -- | -- | -- | YES | >SL |
| Vanadium | 45 | 1.72 | 48.5 | 43/45 | 3.90E+01 | 71 | -- | -- | -- | YES | >SL |
| Zinc | 45 | 1.2 J | 132 J | 45/45 | 2.30E+03 | 3040 | -- | 2000 | 46455 | NO | <SLs |
| **Polycyclic Aromatic Hydrocarbons (µg/kg)** | | | | | | | | | | | |
| Benzo(b)fluoranthene | 2 | 1.5 J | 1.5 J | 1/2 | 1.50E+02 | 490 | -- | -- | -- | NO | <SLs |
| Phenanthrene | 2 | 1.9 J | 2.1 J | 2/2 | -- | 2060000 | -- | -- | -- | NO | <SLs |
| **Other Semivolatile Organic Compounds (µg/kg)** | | | | | | | | | | | |
| Benzoic Acid | 2 | 220 | 220 | 1/2 | 2.40E+07 | 31700000 | -- | -- | -- | NO | <SLs |
| Benzyl Alcohol | 2 | 3.1 J | 3.1 J | 1/2 | 6.10E+02 | -- | -- | -- | -- | NO | <SLs |
| Diethyl Phthalate | 2 | 1.7 J | 1.7 J | 1/2 | 4.90E+06 | 6190 | -- | -- | -- | NO | <SLs |
| Di-n-butyl Phthalate | 2 | 9 J | 9 J | 1/2 | 6.10E+06 | 7900000 | -- | -- | -- | NO | <SLs |
| Pentachlorophenol | 2 | 22 J | 22 J | 1/2 | 8.90E+02 | 3900 | -- | -- | -- | NO | <SLs |
| Phenol | 2 | 4.1 J | 4.1 J | 1/2 | 1.80E+06 | 2320000 | -- | -- | -- | NO | <SLs |

Key:

-- = not available or not applicable
µg/kg = micrograms per kilogram
ADEC = Alaska Department of Environmental Conservation
BLM = Bureau of Land Management
COPC = chemical of potential concern
EPA = United States Environmental Protection Agency

**Table 6-3 Sediment Human Health Screening Results for Red Devil Creek and Kuskokwim River Sediment, Red Devil Mine Site.**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | Frequency of Detection | Soil Human Health Screening Levels | | | | | COPC | Rationale[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | EPA RSL - Residential | ADEC - Direct Contact | ADEC - Outdoor Inhalation | BLM - Human RMC | BLM - Camper RMC | | |

J = estimated value
mg/kg = milligrams per kilogram
PAHs = polycyclic aromatic hydrocarbons
RMC = risk management criteria
SVOCs = semivolatile organic compounds
Shading = Chemical is a selected as a COPC.

Notes:
a = Detected chemicals only are listed.
b = For metals, 42 original site samples and 3 field duplicate samples. For PAHs and SVOCs, 2 original site samples.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = For conservative screening criteria, hexavalent chromium values for used.
e = RSL based on elemental mercury.

Table 6-4 Groundwater Human Health Screening Results, Red Devil Mine Site.

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | Frequency of Detection | Groundwater Human Health Screening Levels | | | COPC | Rationale[c] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | EPA RSL - Tap Water | ADEC - Table C | EPA MCL | | |
| **Total Metals (µg/L)** | | | | | | | | | |
| Aluminum | 31 | 8.8 J | 1460 | 26/31 | 1.60E+03 | -- | -- | NO | <SLs |
| Antimony | 31 | 0.6 J | 13100 | 31/31 | 0.6 | 0.6 | 6 | YES | >SL |
| Arsenic | 31 | 1.3 | 6680 | 31/31 | 4.50E-02 | 1 | 10 | YES | >SL |
| Inorganic Arsenic | 22 | 0.17 | 4530 | 22/22 | 4.50E-02 | 1 | 10 | YES | >SL |
| Barium | 31 | 28.2 | 365 | 31/31 | 2.90E+02 | 200 | 2000 | YES | >SL |
| Beryllium | 31 | 0.006 J | 0.11 | 18/31 | 1.6 | 0.4 | 4 | NO | <SLs |
| Cadmium | 31 | 0.008 J | 0.224 | 28/31 | 0.69 | 0.5 | 5 | NO | <SLs |
| Calcium | 31 | 13200 | 96700 | 31/31 | -- | -- | -- | NO | NUT |
| Chromium[d] | 31 | 0.05 J | 10.6 | 26/31 | 1.60E+03 | 10 | 100 | YES | >SL |
| Cobalt | 31 | 0.045 | 40.5 | 30/31 | 0.47 | -- | -- | YES | >SL |
| Copper | 31 | 0.09 J | 6.29 | 28/31 | 6.20E+01 | 100.0 | 1300 | NO | <SLs |
| Iron | 31 | 5.8 J | 22400 | 28/31 | 1.10E+03 | -- | -- | YES | >SL |
| Lead | 31 | 0.019 J | 2.02 | 26/31 | -- | 1.5 | 15 | YES | >SL |
| Magnesium | 31 | 9800 | 71900 | 31/31 | -- | -- | -- | NO | NUT |
| Manganese | 31 | 1.12 | 7370 | 30/31 | 3.20E+01 | -- | -- | YES | >SL |
| Mercury[e] | 31 | 0.00185 | 56.5 | 31/31 | 6.30E-02 | 0.2 | 2 | YES | >SL |
| Methylmercury | 31 | 0.00006 J | 0.00171 | 27/31 | 0.16 | 0.37 | -- | NO | <SLs |
| Nickel | 31 | 0 | 35.9 | 31/31 | 3.00E+01 | 10 | -- | YES | >SL |
| Potassium | 31 | 259 J | 4930 | 30/31 | -- | -- | -- | NO | NUT |
| Selenium | 31 | 0.3 J | 5.4 | 11/31 | 7.80E+00 | 5 | 50 | YES | >SL |
| Silver | 31 | 0.004 J | 0.049 J | 21/31 | 7.10E+00 | 10 | -- | NO | <SLs |
| Sodium | 31 | 1780 | 20000 | 31/31 | -- | -- | -- | NO | NUT |
| Thallium | 31 | 0.006 J | 0.075 | 18/31 | 1.60E-02 | 0.20 | 2 | YES | >SL |
| Vanadium | 31 | 0.09 J | 3.88 | 27/31 | 7.80E+00 | 26 | -- | NO | <SLs |
| Zinc | 31 | 0.7 | 22 | 28/31 | 4.70E+02 | 500 | -- | NO | <SLs |
| **Dissolved Metals (µg/L)** | | | | | | | | | |
| Aluminum | 32 | 2.1 J | 140 | 22/32 | 1.60E+03 | -- | -- | NO | <SLs |
| Antimony | 32 | 0.317 J | 13100 | 32/32 | 6.00E-01 | 1 | 6 | YES | >SL |
| Arsenic | 32 | 0.4 | 6660 | 32/32 | 4.50E-02 | 1 | 10 | YES | >SL |
| Barium | 32 | 23.3 | 348 | 32/32 | 2.90E+02 | 200 | 2000 | YES | >SL |
| Beryllium | 32 | 0.006 J | 0.041 | 12/32 | 1.60E+00 | 0.4 | 4 | NO | <SLs |
| Cadmium | 32 | 0.006 J | 0.3 J | 26/32 | 6.90E-01 | 1 | | NO | <SLs |
| Calcium | 32 | 7180 | 100000 | 32/32 | -- | -- | -- | NO | NUT |
| Chromium[d] | 32 | 0.09 J | 2.81 | 27/32 | 1.60E+03 | 10 | 100 | NO | <SLs |
| Cobalt | 32 | 0.037 | 41.5 | 31/32 | 4.70E-01 | -- | -- | YES | >SL |
| Copper | 32 | 0.08 J | 1.8 | 29/32 | 6.20E+01 | 100 | 1300 | NO | <SLs |
| Iron | 32 | 3.4 J | 19100 | 24/32 | 1.10E+03 | -- | -- | YES | >SL |
| Lead | 32 | 0.005 J | 0.244 | 21/32 | -- | 1.5 | 15 | NO | <SLs |
| Magnesium | 32 | 2900 | 73500 | 32/32 | -- | -- | -- | NO | NUT |
| Manganese | 32 | 0.606 | 7050 | 31/32 | 3.20E+01 | -- | -- | YES | >SL |

**Table 6-4 Groundwater Human Health Screening Results, Red Devil Mine Site.**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | | Maximum Detected Concentration | | Frequency of Detection | Groundwater Human Health Screening Levels | | | COPC | Rationale[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | EPA RSL - Tap Water | ADEC - Table C | EPA MCL | | |
| Mercury[e] | 32 | 0.00023 | J | 2.2 | | 31/32 | 6.30E-02 | 0.2 | 2 | YES | >SL |
| Nickel | 32 | 0.79 | | 36.3 | | 32/32 | 3.00E+01 | 10 | -- | YES | >SL |
| Potassium | 32 | 211 | J | 4620 | | 31/32 | -- | -- | -- | NO | NUT |
| Selenium | 32 | 0.4 | J | 4.9 | | 11/32 | 7.80E+00 | 5 | 50 | NO | <SLs |
| Silver | 32 | 0.004 | J | 0.013 | J | 3/32 | 7.10E+00 | 10 | -- | NO | <SLs |
| Sodium | 32 | 1880 | | 20000 | | 32/32 | -- | -- | -- | NO | NUT |
| Thallium | 32 | 0.006 | J | 0.059 | | 8/32 | 1.60E-02 | 0 | 2 | YES | >SL |
| Vanadium | 32 | 0.03 | J | 2.03 | | 26/32 | 7.80E+00 | 26 | -- | NO | <SLs |
| Zinc | 32 | 0.2 | J | 20.7 | | 29/32 | 4.70E+02 | 500 | -- | NO | <SLs |
| **Other Compounds (µg/L)** | | | | | | | | | | | |
| Bis(2-ethylhexyl)phthalate | 13 | 5.7 | J | 5.7 | J | 1/13 | 7.10E-02 | 0.6 | -- | YES | >SL |
| Toluene | 5 | 0.09 | J | 1.8 | | 3/15 | 8.60E+01 | 100 | 1000 | NO | <SLs |

Key:
-- = not available or not applicable
µg/L = micrograms per liter
ADEC = Alaska Department of Environmental Conservation
COPC = contaminant l of potential concern
EPA = United States Environmental Protection Agency
J = estimated value
MCL = maximum contaminant level
RSL = regional screening level
Shading = Chemical is a selected as a COPC.

Notes:
a = Detected chemicals only are listed.
b = For total metals, 31 original site samples and 2 field duplicate samples.
c = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level.
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels.
NUT = Essential nutrient (USEPA 1989).
d = RSL based on trivalent chromium.
e = RSL based on elemental mercury.

**Table 6-5 Surface Water Human Health Screening Results from Red Devil Creek, Red Devil Mine Site.**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | Frequency of Detection | Surface Water Human Health | | | COPC | Rationale[c] |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | EPA RSL - Tap Water | ADEC - Table C | EPA MCL | | |
| **Total Metals (µg/L)** | | | | | | | | | |
| Aluminum | 22 | 6.5 J | 30.9 J | 13/22 | 1.60E+03 | -- | -- | NO | <SLs |
| Antimony | 22 | 1.3 | 184 | 22/22 | 0.6 | 0.6 | 6 | YES | >SL |
| Arsenic | 22 | 0.8 | 1030 | 22/22 | 4.50E-02 | 1 | 10 | YES | >SL |
| Inorganic Arsenic | 14 | 0.822 | 745 | 14/14 | 4.50E-02 | 1 | -- | YES | >SL |
| Barium | 22 | 20.6 | 103 | 22/22 | 2.90E+02 | 200 | 2000 | NO | <SLs |
| Beryllium | 22 | 0.009 J | 0.009 J | 1/22 | 1.6 | 0.4 | 4 | NO | <SLs |
| Cadmium | 22 | 0.005 J | 0.008 J | 3/22 | 0.69 | 0.5 | 5 | NO | <SLs |
| Calcium | 22 | 8580 | 36000 | 22/22 | -- | -- | -- | NO | NUT |
| Chromium[d] | 22 | 0.15 J | 0.57 | 13/22 | 1.60E+03 | 10 | 100 | NO | <SLs |
| Cobalt | 22 | 0.046 | 5.3 | 19/22 | 0.47 | -- | -- | YES | >SL |
| Copper | 22 | 0.28 | 0.71 | 14/22 | 6.20E+01 | 100.0 | 1300 | NO | <SLs |
| Iron | 22 | 118 | 2470 | 22/22 | 1.10E+03 | -- | -- | YES | >SL |
| Lead | 22 | 0.008 J | 0.079 | 13/22 | -- | 1.5 | 15 | NO | <SLs |
| Magnesium | 22 | 4460 | 37100 | 22/22 | -- | -- | -- | NO | NUT |
| Manganese | 22 | 11.2 | 379 | 22/22 | 3.20E+01 | -- | -- | YES | >SL |
| Mercury[e] | 22 | 0.00192 | 0.385 | 22/22 | 6.30E-02 | 0.2 | 2 | YES | >SL |
| Methylmercury | 21 | 0.00008 J | 0.00062 | 21/21 | 0.16 | 0.37 | -- | NO | >SL |
| Nickel | 22 | 0.39 | 19.2 | 19/22 | 3.00E+01 | 10 | -- | YES | >SL |
| Potassium | 22 | 172 | 1210 | 13/22 | -- | -- | -- | NO | NUT |
| Selenium | 22 | 0.3 J | 0.5 J | 9/22 | 7.80E+00 | 5 | 50 | NO | <SLs |
| Silver | 22 | 0.008 J | 0.026 | 3/22 | 7.10E+00 | 10 | -- | NO | <SLs |
| Sodium | 22 | 1440 | 12900 | 22/22 | -- | -- | -- | NO | NUT |
| Thallium | 22 | 0.007 J | 0.01 J | 2/22 | 1.60E-02 | 0.20 | 2 | NO | <SLs |
| Vanadium | 22 | 0.1 J | 0.22 J | 13/22 | 7.80E+00 | 26 | -- | NO | <SLs |
| Zinc | 22 | 0.3 J | 2.1 | 9/22 | 4.70E+02 | 500 | -- | NO | <SLs |
| **Dissolved Metals (µg/L)** | | | | | | | | | |
| Aluminum | 21 | 3.5 J | 19.7 J | 12/21 | 1.60E+03 | -- | -- | NO | <SLs |
| Antimony | 21 | 1.2 | 185 | 21/21 | 6.00E-01 | 1 | 6 | YES | >SL |
| Arsenic | 21 | 0.8 | 857 | 21/21 | 4.50E-02 | 1 | 10 | YES | >SL |
| Barium | 21 | 20.7 | 99.5 | 21/21 | 2.90E+02 | 200 | 2000 | NO | <SLs |
| Beryllium | 21 | 0.012 J | 0.012 J | 1/21 | 1.60E+00 | 0.4 | 4 | NO | <SLs |
| Calcium | 21 | 16700 | 36000 | 21/21 | -- | -- | -- | NO | NUT |
| Chromium[d] | 21 | 0.11 J | 0.39 | 12/21 | 1.60E+03 | 10 | 100 | NO | <SLs |
| Cobalt | 21 | 0.041 | 4.9 | 16/21 | 4.70E-01 | -- | -- | YES | >SL |
| Copper | 21 | 0.26 | 0.5 | 12/21 | 6.20E+01 | 100 | 1300 | NO | <SLs |
| Iron | 21 | 70 | 2180 | 21/21 | 1.10E+03 | -- | -- | YES | >SL |
| Lead | 21 | 0.005 J | 0.037 | 7/21 | -- | 1.5 | 15 | NO | <SLs |
| Magnesium | 21 | 8930 | 36400 | 21/21 | -- | -- | -- | NO | NUT |
| Manganese | 21 | 8.2 | 380 | 21/21 | 3.20E+01 | -- | -- | YES | >SL |

Table 6-5  Surface Water Human Health Screening Results from Red Devil Creek, Red Devil Mine Site.

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | | Maximum Detected Concentration | | Frequency of Detection | Surface Water Human Health | | | COPC | Rationale[c] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | EPA RSL - Tap Water | ADEC - Table C | EPA MCL | | |
| Mercury[e] | 21 | 0.00213 | | 0.0161 | | 12/12 | 6.30E-02 | 0.2 | 2 | NO | <SLs |
| Nickel | 21 | 0.32 | | 17 | | 18/21 | 3.00E+01 | 10 | -- | YES | >SL |
| Potassium | 21 | 182 | J | 1170 | | 13/21 | -- | -- | -- | NO | NUT |
| Selenium | 21 | 0.3 | J | 0.6 | J | 8/21 | 7.80E+00 | 5 | 50 | NO | <SLs |
| Silver | 21 | 0.004 | J | 0.009 | J | 3/21 | 7.10E+00 | 10 | -- | NO | <SLs |
| Sodium | 21 | 1430 | | 13000 | | 21/21 | -- | -- | -- | NO | NUT |
| Thallium | 21 | 0.006 | J | 0.006 | J | 1/21 | 1.60E-02 | 0 | 2 | NO | <SLs |
| Vanadium | 21 | 0.07 | J | 0.14 | J | 12/21 | 7.80E+00 | 26 | -- | NO | <SLs |
| Zinc | 21 | 0.3 | J | 1 | | 4/21 | 4.70E+02 | 500 | -- | NO | <SLs |
| **Polycyclic Aromatic Hydrocarbons (PAHs) (µg/L)** | | | | | | | | | | | |
| 1-Methylnaphthalene | 8 | 1.5 | | 1.5 | | 1/8 | 9.70E-01 | 15 | -- | YES | >SL |
| 2-Methylnapthalene | 20 | 1.2 | J | 1.5 | | 2/20 | 2.70E+00 | 15 | -- | NO | <SLs |
| Naphthalene | 20 | 0.68 | J | 0.68 | J | 1/20 | 1.40E-01 | 73 | -- | YES | >SL |

Key:
- -- = not available or not applicable
- µg/L = micrograms per liter
- ADEC = Alaska Department of Environmental Conservation
- COPC = contminant of potential concern
- EPA = United States Environmental Protection Agency
- J = estimated value
- MCL = maximum contaminant level
- PAHs = polycyclic aromatic hydrocarbons
- RSL = Regional Screening Level
- Shading = Chemical is a selected as a COPC.

Notes:
- a = Detected chemicals only are listed.
- b = For total metals, 21 original site samples and 2 field duplicate samples.
- c = Rationale codes.
  - For Yes: >SL = maximum detected concentration exceeds screening level.
    NSL = no screening level available.
  - For No: < SLs = maximum detected concentration less than screening levels.
    NUT = Essential nutrient (USEPA 1989).
- d = RSL based on trivalent chromium.
- e = RSL based on elemental mercury.

## Table 6-6 Final Compounds of Potentail Concern, Red Devil Mine Site.

| Analyte[a] | Surface Soils | Subsurface Soils | Sediment | Surface Water | Groundwater |
|---|---|---|---|---|---|
| **Metals** | | | | | |
| Aluminum | X | X | X | | |
| Antimony | X | X | X | X | X |
| Arsenic | X | X | X | X | X |
| Arsenic (Inorganic) | X | X | X | X | X |
| Barium | X | | X | | X |
| Cadmium | | | BIO | BIO | |
| Chromium | X | X | X | | X |
| Cobalt | X | X | X | X | X |
| Copper | | | BIO | BIO | |
| Iron | X | X | X | X | X |
| Lead | X | X | BIO | BIO | X |
| Manganese | X | X | X | X | X |
| Mercury | X | X | X | X | X |
| Methylmercury | | | BIO | BIO | |
| Nickel | | | X | X | X |
| Selenium | | | BIO | BIO | X |
| Silver | | | BIO | BIO | |
| Thallium | | X | X | | X |
| Vanadium | X | X | X | | |
| Zinc | | | BIO | BIO | |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | |
| 4-Bromophenyl phenyl ether | X | | | | |
| 1-Methylnaphthalene | | | | X | |
| Naphthalene | | X | | X | |
| Bis(2-ethylhexyl)phthalate | | | | | X |

Key:
X = Compound of Potential Concern (COPC) based on screening.
BIO = COPC based on bioaccumulative properties.
SVOC = Semivolatile Organic Compound

**Table 6-7  Comparison of Exposure Unit Metal Concentrations in Soils**

| Geographic Area | Antimony Range (mg/kg) | Antimony Average (mg/kg) | Arsenic Range (mg/kg) | Arsenic Average (mg/kg) | Mercury Range (mg/kg) | Mercury Average (mg/kg) |
|---|---|---|---|---|---|---|
| **Main Processing Area Exposure Unit** | | | | | | |
| Main Processing Area Unit (n=232) | 0.343-2890 | 2163 | 7.77–9880 | 1789 | 0.28-6110 | 244 |
| **Red Devil Creek Downstream Alluvial Area Exposure Unit** | | | | | | |
| RDC Downstream Alluvial Area (n=34) | 0.321-2710 | 360 | 3.36–3510 | 731 | 0.063-471 | 86.8 |
| **Surface Mined Area Exposure Unit** | | | | | | |
| Dolly Sluice and Delta (n=11) | 0.0886-122 | 27 | 12–1200 | 302 | 0.168-326 | 70 |
| Rice Sluice and Delta (n=9) | 1.17-68.7 | 15 | 8.01–142 | 44 | 0.198-33.1 | 8.9 |
| Surface Mined Area (n=40) | 0.25-508 | 84.6 | 8.67–8510 | 1623 | 0.032-174 | 44 |

Key:
mg/kg = milligrams per kilogram
RDC = Red Devil Creek

**Table 6-8**
**Soil Exposure Point Concentration Summary - Resident (SMA)**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Residential (SMA)

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | Reasonable Maximum Exposure | | | EPC Statistic |
|---|---|---|---|---|---|---|---|
| | | | | EPC Units | EPC Value | EPC Distribution | |
| Aluminum | 55 | 1.078E+04 | 2.030E+04 | mg/kg | 1.078E+04 | Gamma | 95% Approx. Gamma UCL |
| Antimony | 55 | 4.947E+01 | 5.080E+02 | mg/kg | 4.947E+01 | Gamma | 95% KM (BCA) UCL |
| Arsenic | 55 | 2.090E+03 | 8.510E+03 | mg/kg | 2.090E+03 | Lognormal | 97.5% KM (Chebyshev) UCL |
| Arsenic (inorganic) | 17 | 5.659E+03 | 2.010E+04 | mg/kg | 5.659E+03 | Gamma | 95% Adjusted Gamma UCL |
| Barium | 55 | 1.910E+02 | 3.390E+02 | mg/kg | 1.910E+02 | Gamma | 95% Approx. Gamma UCL |
| Chromium | 55 | 2.236E+01 | 3.200E+01 | mg/kg | 2.236E+01 | Normal | 95% Student-t UCL |
| Cobalt | 55 | 1.785E+01 | 3.880E+01 | mg/kg | 1.785E+01 | Lognormal | 95% Student-t UCL |
| Iron | 55 | 4.013E+04 | 6.640E+04 | mg/kg | 4.013E+04 | Gamma | 95% Approx. Gamma UCL |
| Lead | 55 | 1.343E+01 | 3.200E+01 | mg/kg | 1.343E+01 | Gamma | 95% Approx. Gamma UCL |
| Manganese | 55 | 8.959E+02 | 4.230E+03 | mg/kg | 8.959E+02 | Gamma | 95% Approx. Gamma UCL |
| Mercury | 55 | 3.943E+01 | 3.260E+02 | mg/kg | 3.943E+01 | Gamma | 95% Adjusted Gamma UCL |
| Thallium | 55 | 2.000E-01 | 1.540E+00 | mg/kg | 2.000E-01 | Non-Parametric | 95% KM (t) UCL |
| Vanadium | 55 | 3.559E+01 | 5.190E+01 | mg/kg | 3.559E+01 | Normal | 95% Student-t UCL |

Key:

EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-9**
**Soil Exposure Point Concentration Summary - Resident (MPA)**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Residential (MPA)

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Aluminum | 212 | 9.364E+03 | 2.170E+04 | mg/kg | 9.364E+03 | Non-Parametric | 95% Chebyshev UCL |
| Antimony | 212 | 4.516E+03 | 2.890E+04 | mg/kg | 4.516E+03 | Non-Parametric | 95% Chebyshev UCL |
| Arsenic | 212 | 2.978E+03 | 9.880E+03 | mg/kg | 2.978E+03 | Non-Parametric | 95% Chebyshev UCL |
| Arsenic (inorganic) | 19 | 7.804E+03 | 1.330E+04 | mg/kg | 7.804E+03 | Normal | 95% Student-t UCL |
| Barium | 212 | 3.790E+02 | 1.710E+03 | mg/kg | 3.790E+02 | Non-Parametric | 95% Chebyshev UCL |
| Chromium | 212 | 2.406E+01 | 1.010E+02 | mg/kg | 2.406E+01 | Non-Parametric | 95% Student-t UCL |
| Cobalt | 212 | 1.613E+01 | 3.500E+01 | mg/kg | 1.613E+01 | Normal | 95% Student-t UCL |
| Iron | 212 | 3.711E+04 | 6.610E+04 | mg/kg | 3.711E+04 | Normal | 95% Student-t UCL |
| Lead | 212 | 1.329E+02 | 3.090E+03 | mg/kg | 1.329E+02 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Manganese | 212 | 7.279E+02 | 1.950E+03 | mg/kg | 7.279E+02 | Gamma | 95% Approx. Gamma UCL |
| Mercury | 212 | 5.060E+02 | 6.110E+03 | mg/kg | 5.060E+02 | Non-Parametric | 95% Chebyshev UCL |
| Thallium | 212 | 1.740E-01 | 6.780E-01 | mg/kg | 1.740E-01 | Non-Parametric | 95% KM (BCA) UCL |
| Vanadium | 212 | 2.980E+01 | 4.950E+01 | mg/kg | 2.980E+01 | Non-Parametric | 95% Student-t UCL |
| Naphthalene | 22 | 5.047E+02 | 3.500E+03 | ug/kg | 5.047E+02 | Gamma | 95% KM (BCA) UCL |

Key:
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-10**
**Soil Exposure Point Concentration Summary - Resident (DA)**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Residential (DA)

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Aluminum | 32 | 1.168E+04 | 1.730E+04 | mg/kg | 1.168E+04 | Normal | 95% Student-t UCL |
| Antimony | 32 | 7.986E+02 | 2.710E+03 | mg/kg | 7.986E+02 | Gamma | 95% KM (Chebyshev) UCL |
| Arsenic | 32 | 1.408E+03 | 3.510E+03 | mg/kg | 1.408E+03 | Non-Parametric | 97.5% Chebyshev UCL |
| Arsenic (inorganic) | 6 | 3.405E+03 | 5.550E+03 | mg/kg | 3.405E+03 | Normal | 95% Student-t UCL |
| Barium | 32 | 2.027E+02 | 5.530E+02 | mg/kg | 2.027E+02 | Gamma | 95% Approx. Gamma UCL |
| Chromium | 32 | 2.430E+01 | 3.110E+01 | mg/kg | 2.430E+01 | Normal | 95% Student-t UCL |
| Cobalt | 32 | 1.275E+01 | 1.900E+01 | mg/kg | 1.275E+01 | Normal | 95% Student-t UCL |
| Iron | 32 | 3.475E+04 | 9.650E+04 | mg/kg | 3.475E+04 | Non-Parametric | 95% Student-t UCL |
| Lead | 32 | 1.047E+01 | 2.150E+01 | mg/kg | 1.047E+01 | Gamma | 95% Approx. Gamma UCL |
| Manganese | 32 | 4.711E+02 | 9.360E+02 | mg/kg | 4.711E+02 | Gamma | 95% KM (BCA) UCL |
| Mercury | 32 | 1.625E+02 | 4.710E+02 | mg/kg | 1.625E+02 | Lognormal | 97.5% Chebyshev UCL |
| Thallium | 32 | 1.950E-01 | 7.540E-01 | mg/kg | 1.950E-01 | Non-Parametric | 95% KM (BCA) UCL |
| Vanadium | 32 | 3.547E+01 | 4.800E+01 | mg/kg | 3.547E+01 | Normal | 95% Student-t UCL |

Key:
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-11**
**Soil Exposure Point Concentraiton Summary - Recreational/Subsistence User and Mine Worker**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Soil
Receptor: Recreationa/Subsistence and Mine Worker

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Aluminum | 299 | 9.278E+03 | 2.170E+04 | mg/kg | 9.278E+03 | Non-Parametric | 95% Chebyshev UCL |
| Antimony | 299 | 3.784E+03 | 2.890E+04 | mg/kg | 3.784E+03 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Arsenic | 299 | 2.615E+03 | 9.880E+03 | mg/kg | 2.615E+03 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Arsenic (inorganic) | 42 | 5.883E+03 | 2.010E+04 | mg/kg | 5.883E+03 | Gamma | 95% Approx. Gamma UCL |
| Barium | 299 | 3.224E+02 | 1.710E+03 | mg/kg | 3.224E+02 | Non-Parametric | 95% Chebyshev UCL |
| Chromium | 299 | 2.345E+01 | 1.010E+02 | mg/kg | 2.345E+01 | Lognormal | 95% Student-t UCL |
| Cobalt | 299 | 1.579E+01 | 3.880E+01 | mg/kg | 1.579E+01 | Gamma | 95% Approx. Gamma UCL |
| Iron | 299 | 3.665E+04 | 9.650E+04 | mg/kg | 3.665E+04 | Non-Parametric | 95% Student-t UCL |
| Lead | 299 | 7.761E+01 | 3.090E+03 | mg/kg | 7.761E+01 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Manganese | 299 | 7.137E+02 | 4.230E+03 | mg/kg | 7.137E+02 | Gamma | 95% KM (BCA) UCL |
| Mercury | 299 | 3.728E+02 | 6.110E+03 | mg/kg | 3.728E+02 | Non-Parametric | 95% Chebyshev UCL |
| Thallium | 299 | 1.710E-01 | 1.540E+00 | mg/kg | 1.710E-01 | Non-Parametric | 95% KM (t) UCL |
| Vanadium | 299 | 3.110E+01 | 5.190E+01 | mg/kg | 3.110E+01 | Non-Parametric | 95% Student-t UCL |
| Naphthalene | 22 | 5.047E+02 | 3.500E+03 | ug/kg | 5.047E+02 | Gamma | 95% KM (t) UCL |

Key:
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-12**
**Sediment Exposure Point Concentration Summary**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Red Devil Creek and Near-Shore Kuskokwim River Sediments

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Aluminum | 25 | 1.082E+04 | 1.700E+04 | mg/kg | 1.082E+04 | Normal | 95% Student-t UCL |
| Antimony | 25 | 4.455E+03 | 6.360E+03 | mg/kg | 4.455E+03 | Non-Parametric | 99% KM (Chebyshev) UCL |
| Arsenic | 25 | 3.830E+04 | 1.300E+05 | mg/kg | 3.830E+04 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Arsenic (Inorganic) | 23 | 6.001E+04 | 1.880E+05 | mg/kg | 6.001E+04 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Barium | 25 | 6.806E+02 | 1.990E+03 | mg/kg | 6.806E+02 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Cadmium | 25 | 2.920E-01 | 6.000E-01 | mg/kg | 2.920E-01 | Normal | 95% KM (t) UCL |
| Chromium | 25 | 2.574E+01 | 4.740E+01 | mg/kg | 2.574E+01 | Normal | 95% KM (t) UCL |
| Cobalt | 25 | 1.711E+01 | 5.000E+01 | mg/kg | 1.711E+01 | Gamma | 95% Approx. Gamma UCL |
| Copper | 25 | 3.716E+01 | 5.820E+01 | mg/kg | 3.716E+01 | Gamma | 95% Approx. Gamma UCL |
| Iron | 25 | 9.919E+04 | 3.440E+05 | mg/kg | 9.919E+04 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Lead | 25 | 9.292E+00 | 1.400E+01 | mg/kg | 9.292E+00 | Normal | 95% KM (t) UCL |
| Manganese | 25 | 2.015E+03 | 5.410E+03 | mg/kg | 2.015E+03 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Mercury | 25 | 6.659E+01 | 1.190E+02 | mg/kg | 6.659E+01 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Methyl Mercury | 25 | 5.228E-03 | 1.440E-02 | mg/kg | 5.228E-03 | Lognormal | 97.5% KM (Chebyshev) UCL |
| Nickel | 25 | 5.697E+01 | 2.400E+02 | mg/kg | 5.697E+01 | Gamma | 95% Approx. Gamma UCL |
| Selenium | 25 | 4.870E-01 | 6.200E-01 | mg/kg | 4.870E-01 | Normal | 95% KM (t) UCL |
| Silver | 25 | 1.140E-01 | 2.290E-01 | mg/kg | 1.140E-01 | Normal | 95% KM (t) UCL |
| Thallium | 25 | 1.490E-01 | 2.970E-01 | mg/kg | 1.490E-01 | Gamma | 95% KM (t) UCL |
| Vanadium | 25 | 3.097E+01 | 4.850E+01 | mg/kg | 3.097E+01 | Normal | 95% KM (t) UCL |
| Zinc | 25 | 9.161E+01 | 1.200E+02 | mg/kg | 9.161E+01 | Normal | 95% Student-t UCL |

Key:
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-13**
**Surface Water Exposure Point Concentration Summary**
**RED DEVIL MINE**

Scenario Timeframe: Current/Future
Medium: Red Devil Creek Surface Water (Total)

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Antimony | 19 | 1.355E+02 | 1.840E+02 | ug/L | 1.355E+02 | Gamma | 95% Approx. Gamma UCL |
| Arsenic | 19 | 8.113E+02 | 1.030E+03 | ug/L | 8.113E+02 | Non-Parametric | 99% KM (Chebyshev) UCL |
| Arsenic (Inorganic) | 12 | 5.726E+02 | 7.450E+02 | ug/L | 5.726E+02 | Gamma | 95% Approx. Gamma UCL |
| Cadmium | 19 | 6.000E-03 | 8.000E-03 | ug/L | 6.000E-03 | Normal | 95% KM (t) UCL |
| Cobalt | 19 | 3.039E+00 | 5.300E+00 | ug/L | 3.039E+00 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Copper | 19 | 4.310E-01 | 7.100E-01 | ug/L | 4.310E-01 | Normal | 95% KM (t) UCL |
| Iron | 19 | 1.325E+03 | 2.470E+03 | ug/L | 1.325E+03 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Lead | 19 | 3.400E-02 | 7.900E-02 | ug/L | 3.400E-02 | Gamma | 95% KM (t) UCL |
| Manganese | 19 | 1.706E+02 | 3.790E+02 | ug/L | 1.706E+02 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Mercury | 19 | 2.410E-01 | 3.850E-01 | ug/L | 2.410E-01 | Gamma | 95% Approx. Gamma UCL |
| Methyl Mercury | 19 | 3.130E-04 | 6.200E-04 | ug/L | 3.130E-04 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Nickel | 19 | 1.054E+01 | 1.920E+01 | ug/L | 1.054E+01 | Non-Parametric | 97.5% KM (Chebyshev) UCL |
| Selenium | 19 | 3.850E-01 | 5.000E-01 | ug/L | 3.850E-01 | Normal | 95% KM (t) UCL |
| Silver | 19 | -- | 2.600E-02 | ug/L | 2.600E-02 | -- | Maximum detection |
| Zinc | 19 | 7.270E-01 | 2.100E+00 | ug/L | 7.270E-01 | Non-Parametric | 95% KM (t) UCL |
| 1-Methylnaphthalene | 7 | -- | 1.500E+00 | ug/L | 1.500E+00 | -- | Maximum detection |
| Naphthalene | 17 | -- | 6.800E-01 | ug/L | 6.800E-01 | -- | Maximum detection |

Key:
-- = Not calculated due to insufficient number of detected results.
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available

**Table 6-14**
**Groundwater Exposure Point Concentration Summary**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Groundwater (Total)

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Antimony | 29 | 5.609E+03 | 1.310E+04 | ug/L | 5.609E+03 | Lognormal | 99% Chebyshev UCL |
| Arsenic | 29 | 2.403E+03 | 6.680E+03 | ug/L | 2.403E+03 | Normal | 97.5% Chebyshev UCL |
| Arsenic (Inorganic) | 20 | 1.802E+03 | 4.530E+03 | ug/L | 1.802E+03 | Lognormal | 97.5% Chebyshev UCL |
| Barium | 29 | 1.006E+02 | 3.650E+02 | ug/L | 1.006E+02 | Gamma | 95% Approx. Gamma UCL |
| Chromium | 29 | 3.506E+00 | 1.060E+01 | ug/L | 3.506E+00 | Gamma | 95% KM (Chebyshev) UCL |
| Cobalt | 29 | 9.785E+00 | 4.050E+01 | ug/L | 9.785E+00 | Gamma | 95% KM (Chebyshev) UCL |
| Iron | 29 | 8.042E+03 | 2.240E+04 | ug/L | 8.042E+03 | Gamma | 95% KM (Chebyshev) UCL |
| Lead | 29 | 6.710E-01 | 2.020E+00 | ug/L | 6.710E-01 | Gamma | 95% KM (Chebyshev) UCL |
| Manganese | 29 | 2.243E+03 | 7.370E+03 | ug/L | 2.243E+03 | Gamma | 95% KM (Chebyshev) UCL |
| Mercury | 29 | 1.479E+01 | 5.650E+01 | ug/L | 1.479E+01 | Lognormal | 97.5% Chebyshev UCL |
| Nickel | 29 | 1.729E+01 | 3.590E+01 | ug/L | 1.729E+01 | Gamma | 95% Approx. Gamma UCL |
| Selenium | 29 | 9.170E-01 | 5.400E+00 | ug/L | 9.170E-01 | Lognormal | 95% KM (t) UCL |
| Thallium | 29 | 1.710E-02 | 7.500E-02 | ug/L | 1.710E-02 | Non-Parametric | 95% KM (BCA) UCL |
| Bis(2-ethylhexyl)phthalate | 11 | -- | 5.700E+00 | ug/L | 5.700E+00 | -- | Maximum detection |

Key:
-- = Not calculated due to insufficient number of detected results.
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-15**
**Slimy Sculpin Exposure Point Concentration Summary**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Slimy Sculpin

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Aluminum | 21 | 3.224E+01 | 7.250E+01 | mg/kg-wet | 3.224E+01 | Gamma | 95% Approx. Gamma UCL |
| Antimony | 21 | 1.706E+01 | 3.810E+01 | mg/kg-wet | 1.706E+01 | Gamma | 95% Approx. Gamma UCL |
| Arsenic | 21 | 1.140E+01 | 2.406E+01 | mg/kg-wet | 1.140E+01 | Normal | 95% Student-t UCL |
| Barium | 21 | 3.787E+00 | 5.402E+00 | mg/kg-wet | 3.787E+00 | Normal | 95% Student-t UCL |
| Cadmium | 21 | 4.420E-02 | 1.030E-01 | mg/kg-wet | 4.420E-02 | Gamma | 95% KM (t) UCL |
| Chromium | 21 | 6.800E-01 | 2.431E+00 | mg/kg-wet | 6.800E-01 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Cobalt | 21 | -- | -- | -- | -- | -- | -- |
| Copper | 21 | 1.252E+00 | 2.263E+00 | mg/kg-wet | 1.252E+00 | Non-Parametric | 95% Student-t UCL |
| Iron | 21 | 8.889E+01 | 1.837E+02 | mg/kg-wet | 8.889E+01 | Normal | 95% Student-t UCL |
| Lead | 21 | 3.760E-02 | 7.900E-02 | mg/kg-wet | 3.760E-02 | Gamma | 95% KM UCL |
| Manganese | 21 | 1.250E+01 | 2.128E+01 | mg/kg-wet | 1.250E+01 | Lognormal | 95% Student-t UCL |
| Mercury | 21 | 2.140E+00 | 3.701E+00 | mg/kg-wet | 2.140E+00 | Gamma | 95% Approx. Gamma UCL |
| Nickel | 21 | 1.470E-01 | 2.630E-01 | mg/kg-wet | 1.470E-01 | Normal | 95% Student-t UCL |
| Selenium | 21 | 1.891E+00 | 2.975E+00 | mg/kg-wet | 1.891E+00 | Normal | 95% Student-t UCL |
| Silver | 21 | -- | -- | -- | -- | -- | -- |
| Thallium | 21 | -- | -- | -- | -- | -- | -- |
| Vanadium | 21 | 2.210E-01 | 3.590E-01 | mg/kg-wet | 2.210E-01 | Normal | 95% Student-t UCL |
| Zinc | 21 | 2.656E+01 | 3.537E+01 | mg/kg-wet | 2.656E+01 | Normal | 95% Student-t UCL |

Key:
-- = Not calculated due to insufficient number of detected results.
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-16**
**Green Alder Bark Exposure Point Concentration Summary**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: Green Alder Bark

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Aluminum | 8 | 1.587E+01 | 2.420E+01 | mg/kg | 1.587E+01 | Normal | 95% Student-t UCL |
| Antimony | 8 | 2.724E+00 | 3.350E+00 | mg/kg | 2.724E+00 | Gamma | 95% Approx. Gamma UCL |
| Arsenic | 8 | 5.320E-01 | 9.100E-01 | mg/kg | 5.320E-01 | Normal | 95% Student-t UCL |
| Arsenic (inorganic) | | NA | NA | | NA | NA | NA |
| Barium | 8 | 1.552E+02 | 2.030E+02 | mg/kg | 1.552E+02 | Normal | 95% Student-t UCL |
| Chromium | 8 | 8.550E-01 | 1.400E+00 | mg/kg | 8.550E-01 | Normal | 95% KM (t) UCL |
| Cobalt | 8 | 3.350E-01 | 5.280E-01 | mg/kg | 3.350E-01 | Gamma | 95% Approx. Gamma UCL |
| Iron | 8 | 2.957E+01 | 3.490E+01 | mg/kg | 2.957E+01 | Normal | 95% Student-t UCL |
| Lead | 8 | 1.020E-01 | 1.130E-01 | mg/kg | 1.020E-01 | Normal | 95% Student-t UCL |
| Manganese | 8 | 7.149E+02 | 1.140E+03 | mg/kg | 7.149E+02 | Normal | 95% Student-t UCL |
| Mercury | 8 | 2.100E-01 | 2.890E-01 | mg/kg | 2.100E-01 | Normal | 95% Student-t UCL |
| Thallium | 8 | 1.620E-02 | 3.000E-02 | mg/kg | 1.620E-02 | Normal | 95% Student-t UCL |
| Vanadium | 8 | 6.450E-02 | 7.000E-02 | mg/kg | 6.450E-02 | Normal | 95% KM (t) UCL |

Key:
-- = Not calculated due to insufficient number of detected results.
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

**Table 6-17**
**White Spruce Needles Exposure Point Concentration Summary**
**Red Devil Mine**

Scenario Timeframe: Current/Future
Medium: White Spruce Needles

| Contaminant of Potential Concern | Number of Samples | 95% UCL | Maximum Detected Concentration | EPC Units | Reasonable Maximum Exposure | | |
|---|---|---|---|---|---|---|---|
| | | | | | EPC Value | EPC Distribution | EPC Statistic |
| Aluminum | 8 | 1.295E+02 | 1.720E+02 | mg/kg | 1.295E+02 | Gamma | 95% KM (Chebyshev) UCL |
| Antimony | 8 | 1.032E+01 | 1.510E+01 | mg/kg | 1.032E+01 | Lognormal | 95% KM (Chebyshev) UCL |
| Arsenic | 8 | 7.577E+00 | 1.110E+01 | mg/kg | 7.577E+00 | Lognormal | 95% KM (Chebyshev) UCL |
| Arsenic (inorganic) | | NA | NA | | NA | NA | NA |
| Barium | 8 | 5.988E+01 | 8.530E+01 | mg/kg | 5.988E+01 | Normal | 95% Student-t UCL |
| Chromium | 8 | 8.350E-01 | 1.300E+00 | mg/kg | 8.350E-01 | Normal | 95% KM (t) UCL |
| Cobalt | 8 | 2.330E-01 | 3.030E-01 | mg/kg | 2.330E-01 | Normal | 95% Student-t UCL |
| Iron | 8 | 1.972E+02 | 2.060E+02 | mg/kg | 1.972E+02 | Non-Parametric | 95% KM (Chebyshev) UCL |
| Lead | 8 | 3.350E-01 | 4.660E-01 | mg/kg | 3.350E-01 | Lognormal | 95% KM (Chebyshev) UCL |
| Manganese | 8 | 1.904E+03 | 2.990E+03 | mg/kg | 1.904E+03 | Gamma | 95% Approx. Gamma UCL |
| Mercury | 8 | 5.694E+00 | 5.640E+00 | mg/kg | 5.640E+00 | Gamma | 95% Adjusted Gamma UCL |
| Thallium | 8 | -- | 2.100E-01 | mg/kg | 2.100E-01 | Non-Parametric | Maximum, only 2 detections |
| Vanadium | 8 | 9.170E-01 | 4.700E-01 | mg/kg | 9.170E-01 | Non-Parametric | Maximum, 95%UCL > Max |

Key:
-- = Not calculated due to insufficient number of detected results.
EPC = Exposure Point Concentration
KM = Kaplan-Meier (statistical evaluation)
Max = Maximum Detected
NA = Not available
UCL = Upper Confidence Limit

## Table 6-18. Dermal Chemical Specific Values

| Compound of Potential Concern | ABSd Value | Kp (cm/hr) |
|---|---|---|
| **Metals** | | |
| Aluminum | NA | 1.00E-03 |
| Antimony | NA | 1.00E-03 |
| Arsenic | 0.03 | 1.00E-03 |
| Arsenic (Inorganic) | 0.03 | 1.00E-03 |
| Barium | NA | 1.00E-03 |
| Cadmium | 0.001 | 1.00E-03 |
| Chromium | NA | 1.00E-03 |
| Cobalt | NA | 4.00E-04 |
| Copper | NA | 1.00E-03 |
| Iron | NA | 1.00E-03 |
| Manganese | NA | 1.00E-03 |
| Mercury | NA | 1.00E-03 |
| Nickel | NA | 2.00E-04 |
| Selenium | NA | 1.00E-03 |
| Silver | NA | 6.00E-04 |
| Thallium | NA | 1.00E-03 |
| Vanadium | NA | 1.00E-03 |
| Zinc | NA | 6.00E-04 |
| **Organometals** | | |
| Methyl mercury | NA | 1.00E-03 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | |
| 1-Methylnaphthalene | 0.13 | -- |
| Naphthalene | 0.13 | 4.70E-02 |
| **Semivolatile Organic Compounds** | | |
| Bis(2-Ethylhexyl)phthalate | 0.1 | -- |

Key:
ABSd = Dermal Absorption Fraction, from RAGS Part E (2004)
NA = Not available
Kp = Dermal permeability coefficient of compound in water (cm/hr), from RAGS Part E (2004).

**Table 6-19 Summary of Exposure Factors and Intake Equations**

| Medium | Exposure Route | Parameter Code | Parameter Definition | Units | Future Residential | | Recreational/Subsistence User | | Mine Worker | Intake Equation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Adult Value | Child Value | Adult Value | Child Value | Adult Value | |
| Soil | Ingestion | $CDI_{soil}$ | Chronic Daily Intake of Chemical - soil/sediment | mg/kg-d | -- | -- | -- | -- | -- | $Intake\,(mg/kg/day) = \frac{C_s \; x\, IR\, x\, CF\, x\, EF\, x\, ED}{BW\; x\, AT}$ |
| | | $C_{soil}$ | Exposure Point Concentration - soil/sediment | mg/kg | 95% UCL | 95% UCL | 95% UCL | 95% UCL | 95% UCL | |
| | | $IR_{soil}$ | Ingestion Rate - soil/sediment | mg/day | 100 | 200 | 100 | 200 | 100 | |
| | | $EF_{soil}$ | Exposure Frequency - soil/sediment | d/y | 270 | 270 | 90 | 90 | 250 | |
| | | $ED_{soil}$ | Exposure Duration - soil/sediment | y | 30 | 6 | 30 | 6 | 25 | |
| | | BW | Body Weight | kg | 70 | 15 | 70 | 15 | 70 | |
| | | $AT_c$ | Averaging Time - cancer | days | 25,550 | | 25,550 | | 25,550 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | 10,950 | 2,190 | 10,950 | 2,190 | 9,125 | |
| | | CF | Conversion Factor | kg/mg | 1.00E-06 | 1.00E-06 | 1.00E-06 | 1.00E-06 | 1.00E-06 | |
| Soil | Dermal | DAD | Dermally Absorbed Dose | mg/kg-d | -- | -- | -- | -- | -- | $DAD\,(mg/kg/day) = \frac{C_s \; x\, SA\, x\, AF\; x\, ABS\; x\, CF\; x\, EF\; x\, ED \times EV}{BW\; x\, AT}$ |
| | | $C_{soil}$ | Exposure Point Concentration - soil/sediment | unitless | 95% UCL | 95% UCL | 95% UCL | 95% UCL | 95% UCL | |
| | | SA | Surface Area | $cm^2$ | 5,700.0 | 2,800.0 | 5,700 | 2,800 | 3,300.0 | |
| | | AF | Soil-to-skin Adherence Factor | $mg/cm^2$-event | 0.07 | 0.2 | 0.07 | 0.2 | 0.2 | |
| | | $ABS_{dermal}$ | Dermal Absorption Fraction | Unitless | Chemical-specific | | | | | |
| | | $EF_{soil}$ | Exposure Frequency - soil/sediment | d/y | 270 | 270 | 90 | 90 | 250 | |
| | | $ED_{soil}$ | Exposure Duration - soil/sediment | y | 30 | 6 | 30 | 6 | 25 | |
| | | EV | Event Frequency | evetns/day | 1 | 1 | 1 | 1 | 1 | |
| | | BW | Body Weight | kg | 70 | 15 | 70 | 15 | 70 | |
| | | $AT_c$ | Averaging Time - cancer | days | 25,550 | | 25,550 | | 25,550 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | 10,950 | 2,190 | 10,950 | 2,190 | 9,125 | |
| | | CF | Conversion Factor | kg/mg | 1.00E-06 | 1.00E-06 | 1.00E-06 | 1.00E-06 | 1.00E-06 | |
| Sediment | Dermal | DAD | Dermally Absorbed Dose | mg/kg-d | -- | -- | -- | -- | -- | $DAD\,(mg/kg/day) = \frac{C_s \; x\, SA\, x\, AF\; x\, ABS\; x\, CF\; x\, EF\; x\, ED \times EV}{BW\; x\, AT}$ |
| | | $C_{soil}$ | Exposure Point Concentration - soil/sediment | unitless | 95% UCL | 95% UCL | 95% UCL | 95% UCL | 95% UCL | |
| | | SA | Surface Area | $cm^2$ | 5,700.0 | 2,800.0 | 5,700 | 2,800 | 3,300.0 | |
| | | AF | Soil-to-skin Adherence Factor | $mg/cm^2$-event | 0.07 | 0.2 | 0.07 | 0.2 | 0.2 | |
| | | $ABS_{dermal}$ | Dermal Absorption Fraction | Unitless | Chemical-specific | | | | | |
| | | $EF_{soil}$ | Exposure Frequency - soil/sediment | d/y | 90 | 90 | 90 | 90 | 90 | |
| | | $ED_{soil}$ | Exposure Duration - soil/sediment | y | 30 | 6 | 30 | 6 | 25 | |
| | | EV | Event Frequency | evetns/day | 1 | 1 | 1 | 1 | 1 | |
| | | BW | Body Weight | kg | 70 | 15 | 70 | 15 | 70 | |
| | | $AT_c$ | Averaging Time - cancer | days | 25,550 | | 25,550 | | 25,550 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | 10,950 | 2,190 | 10,950 | 2,190 | 9,125 | |
| | | CF | Conversion Factor | kg/mg | 1.00E-06 | 1.00E-06 | 1.00E-06 | 1.00E-06 | 1.00E-06 | |
| Groundwater | Ingestion | $CDI_{gw}$ | Chronic Daily Intake of Chemical - groundwater | mg/kg-d | -- | -- | -- | -- | -- | $Intake\,(mg/kg/day) = \frac{C_w \; x\, IR\;\, x\, EF\;\, x\, ED \times CF}{BW\;\, x\, AT}$ |
| | | $C_w$ | Exposure Point Concentration - groundwater | ug/L | 95% UCL | 95% UCL | -- | -- | 95% UCL | |
| | | $IR_{gw}$ | Ingestion Rate - groundwater | L/day | 2 | 1 | -- | -- | 2 | |
| | | $EF_{gw}$ | Exposure Frequency - groundwater | d/y | 350 | 350 | -- | -- | 250 | |
| | | $ED_{gw}$ | Exposure Duration - groundwater | y | 30 | 6 | -- | -- | 25 | |
| | | BW | Body Weight | kg | 70 | 15 | -- | -- | 70 | |
| | | $AT_c$ | Averaging Time - cancer | days | 25,550 | | -- | -- | 25,550 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | 10,950 | 2,190 | -- | -- | 9,125 | |
| | | CF | Conversion Factor | mg/ug | 1.00E-03 | 1.00E-03 | -- | -- | 1.00E-03 | |

**Table 6-19 Summary of Exposure Factors and Intake Equations**

| Medium | Exposure Route | Parameter Code | Parameter Definition | Units | Future Residential | | Recreational/Subsistence User | | Mine Worker | Intake Equation |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Adult Value | Child Value | Adult Value | Child Value | Adult Value | |
| Groundwater | Dermal | DAD | Dermally Absorbed Dose | mg/kg-d | -- | -- | -- | -- | -- | |
| | | $C_w$ | Exposure Point Concentration - groundwater | ug/L | 95% UCL | 95% UCL | -- | -- | 95% UCL | |
| | | $DA_{event}$ | Absorbed Dose Per Event | $mg/cm^2$-event | Chemical- and event-specific | | | | | |
| | | SA | Surface Area | $cm^2$ | 18,000 | 6,600 | -- | -- | 18,000 | |
| | | EV | Event Frequency | evetns/day | 1 | 1 | -- | -- | 1 | $DAD(mg/kg/day) = \frac{DAevent\ x\ EV\ x\ ED\ x\ EF\ x\ SA}{BW\ x\ AT}$ |
| | | $EF_{gw}$ | Exposure Frequency - groundwater | d/y | 350 | 350 | -- | -- | 250 | |
| | | $ED_{gw}$ | Exposure Duration - groundwater | y | 30 | 6 | -- | -- | 25 | |
| | | BW | Body Weight | kg | 70 | 15 | -- | -- | 70 | |
| | | $AT_c$ | Averaging Time - cancer | days | 25,550 | | -- | -- | 25,550 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | 10,950 | 2,190 | -- | -- | 9,125 | |
| Surface Water | Ingestion | $CDI_{sw}$ | Chronic Daily Intake of Chemical - surface water | mg/kg-d | -- | -- | -- | -- | -- | |
| | | $C_{sw}$ | Exposure Point Concentration - surface water | mg/L | -- | -- | 95% UCL | 95% UCL | -- | |
| | | $IR_{sw}$ | Ingestion Rate - surface water | L/day | -- | -- | 2 | 1 | -- | |
| | | $EF_{sw}$ | Exposure Frequency - surface water | d/y | -- | -- | 20 | 20 | -- | $Intake(mg/kg/day) = \frac{C_{SW}\ x\ IR\ x\ EF\ x\ ED \times CF}{BW\ x\ AT}$ |
| | | $ED_{sw}$ | Exposure Duration - surface water | y | -- | -- | 30 | 6 | -- | |
| | | BW | Body Weight | kg | -- | -- | 70 | 15 | -- | |
| | | $AT_c$ | Averaging Time - cancer | days | -- | -- | ED*365 | ED*365 | -- | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | -- | -- | 10,950 | 2,190 | -- | |
| | | CF | Conversion Factor | mg/ug | -- | -- | 1.00E-03 | 1.00E-03 | -- | |
| Surface Water | Dermal | DAD | Dermally Absorbed Dose | mg/kg-d | -- | -- | -- | -- | -- | |
| | | $C_{sw}$ | Exposure Point Concentration - surface water | ug/L | 95% UCL | 95% UCL | 95% UCL | 95% UCL | 95% UCL | |
| | | $DA_{event}$ | Absorbed Dose Per Event | $mg/cm^2$-event | Chemical- and event-specific | | | | | |
| | | SA | Surface Area | $cm^2$ | 5,672 | 4,150 | 5,672 | 4,150 | 5,672 | |
| | | EV | Event Frequency | evetns/day | 1 | 1 | 1 | 1 | 1 | |
| | | $EF_{sw}$ | Exposure Frequency - surface water | d/y | 60 | 60 | 20 | 20 | 40 | $DAD(mg/kg/day) = \frac{DAevent\ x\ EV\ x\ ED\ x\ EF\ x\ SA}{BW\ x\ AT}$ |
| | | $ED_{sw}$ | Exposure Duration - surface water | y | 30 | 6 | 30 | 6 | 25 | |
| | | BW | Body Weight | kg | 70 | 15 | 70 | 15 | 70 | |
| | | $AT_c$ | Averaging Time - cancer | days | 25,550 | | 25,550 | | 25,550 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | 10,950 | 2,190 | 10,950 | 2,190 | 9,125 | |
| Air (Particulate or Volatiles from Soil) | Inhalation | EC | Exposure Concentration | $mg/m^3$ | -- | -- | -- | -- | -- | |
| | | $C_a$ | Modeled concentration in air | $mg/m^3$ | Chemical-specific | | | | | |
| | | ET | Exposure time | hours/day | 24 | 24 | 24 | 24 | 8 | |
| | | $EF_{air}$ | Exposure Frequency - air | d/y | 270 | 270 | 90 | 90 | 250 | $EC(mg/m^3) = \frac{C_a\ x\ ET\ x\ EF\ x\ ED}{AT}$ |
| | | $ED_{air}$ | Exposure Duration - air | y | 30 | 6 | 30 | 6 | 25 | |
| | | $AT_c$ | Averaging Time - cancer | hours | 25,550 | | 25,550 | | 613,200 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | hours | 262,800 | 52,560 | 262,800 | 52,560 | 219,000 | |
| Air (Volatiles from Groundwater) | Inhalation | EC | Exposure Concentration | $mg/m^3$ | -- | -- | -- | -- | -- | |
| | | $C_a$ | Modeled concentration in air | $mg/m^3$ | Chemical-specific | | | | | |
| | | ET | Exposure time | hours/day | 0.75 | 0.75 | -- | -- | - | $EC(mg/m^3) = \frac{C_a\ x\ ET\ x\ EF\ x\ ED}{AT}$ |
| | | $EF_{air}$ | Exposure Frequency - air | d/y | 350 | 350 | -- | -- | - | |
| | | $ED_{air}$ | Exposure Duration - air | y | 30 | 6 | -- | -- | - | |
| | | $AT_c$ | Averaging Time - cancer | hours | 25,550 | | -- | -- | - | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | hours | 262,800 | 52,560 | -- | -- | - | |

**Table 6-19 Summary of Exposure Factors and Intake Equations**

| Medium | Exposure Route | Parameter Code | Parameter Definition | Units | Future Residential Adult Value | Future Residential Child Value | Recreational/Subsistence User Adult Value | Recreational/Subsistence User Child Value | Mine Worker Adult Value | Intake Equation |
|---|---|---|---|---|---|---|---|---|---|---|
| Subsistence Foods | Ingestion | $CDI_{sub}$ | Chronic Daily Intake of Chemical - subsistence foods | mg/kg-d | -- | -- | -- | -- | -- | $$Intake(mg/kg/day) = \frac{Cf\ x\ IR\ x\ FI\ x\ EF\ x\ ED}{BW\ x\ AT}$$ |
| | | Cf | Modeled concentration in subsistence foods (separate for whitefish, moose, beaver, grouse and blueberries) | mg/kg | 95% UCL | 95% UCL | 95% UCL | 95% UCL | 95% UCL | |
| | | IRfish | Ingestion Rate - non-salmon fish (whitefish) | kg/d | 0.271 | 0.130 | 0.271 | 0.130 | 0.271 | |
| | | FIfish | Fractional Intake from contaminated source for non-salmon fish (whitefish) | unitless | 1.000 | 1.000 | 0.200 | 0.200 | 0.200 | |
| | | Irllm | Ingestion Rate - large land mammals (moose) | kg/d | 0.076 | 0.036 | 0.076 | 0.036 | 0.076 | |
| | | FIllm | Fractional Intake from contaminated source - large land mammals (moose) | unitless | 1.000 | 1.000 | 0.014 | 0.014 | 0.014 | |
| | | IRslm | Ingestion Rate - small land mammals (beaver) | kg/d | 0.037 | 0.018 | 0.037 | 0.018 | 0.037 | |
| | | FIslm | Fractional Intake from contaminated source - small land mammals (beaver) | unitless | 1.000 | 1.000 | 0.020 | 0.020 | 0.020 | |
| | | Irbird | Ingestion Rate - birds (grouse) | kg/d | 0.011 | 0.005 | 0.011 | 0.005 | 0.011 | |
| | | Fibirds | Fractional Intake from contaminated source - birds (grouse) | unitless | 1.000 | 1.000 | 0.330 | 0.330 | 0.330 | |
| | | Irberries | Ingestion Rate - berries and plants (blueberries) | kg/d | 0.014 | 0.007 | 0.014 | 0.007 | 0.014 | |
| | | Fiberries | Fractional Intake from contaminated source - berries and plants (blueberries) | unitless | 1.000 | 1.000 | 0.010 | 0.010 | 0.010 | |
| | | $EF_{sub}$ | Exposure Frequency - subsistence foods | d/y | 365 | 365 | 365 | 365 | 250 | |
| | | $ED_{sub}$ | Exposure Duration - subsistence foods | y | 30 | 6 | 30 | 6 | 25 | |
| | | $BW_a$ | Body Weight | kg | 70 | 15 | 70 | 15 | 70 | |
| | | $AT_c$ | Averaging Time - cancer | days | 25,550 | | 25,550 | | 25,550 | |
| | | $AT_{nc}$ | Averaging Time - non-cancer | days | 10,950 | 2,190 | 10,950 | 2,190 | 9,125 | |

**Table 6.20 Available Harvest Rates, Pre-2012**

| Food Source | Ballew et al. (2004) – Median (g/day) | IDM (1997) - 50th Percentile Harvest (g/day) | IDM (1997) - 95th Percentile Harvest (g/day) | EFH (2011) (g/day) |
|---|---|---|---|---|
| **Salmon** | 68 | 76.8 | 967.9 | See Table 2 |
| **Non-Salmon Fish** | 16 | 27.8 | 149.6 | See Table 2 |
| **Large Land Mammal** | 47 | 76.1 | 199.5 | NA |
| **Berries** | 21 | NA | NA | 18.2 |
| **Birds** | 5 | NA | NA | NA |

Key:
EFH = Exposure Factors Handbook
g/day = grams per day
NA = Not available

**Table 6-21 Native American Fish Ingestion Rates**

| | Ingestion Rates (g/day) [1] | | | | |
|---|---|---|---|---|---|
| | Wolfe and Walker (1987) | Toy et al. (1996) – Tulalip | Toy et al. (1996) – Squaxin | Duncan (2000) – Suquamish | IDM (1997) – Subarctic Interior[2] |
| ***95th Percentile*** | | | | | |
| **Adult** | NA | 203 | 210 | 700 | 1117.5 |
| **Child** | NA | 10.5 | 31.5 | 109.5 | NA |
| | | | | | |
| ***Mean*** | | | | | |
| **Adult** | 81[3] | 63 | 63 | 189 | 104.6 |
| **Child** | NA | 3 | 12 | 22.5 | NA |

**Notes:**
1 – Body weight adjusted, if needed, at 70 kg for adult and 15 kg for child
2 – Sum of salmon and non-salmon harvest rate for 50th (mean) and 95th percentile
3 - Represents median value
**Key:**
NA = Not available

**Table 6-22 Wild Food Ingestion Rates**

| Food Source Category | Indicator Species | Key Study, Community | Adult IR (g/day) |
|---|---|---|---|
| **Non-Salmon Fish** | Whitefish | ADF&G 2012 Red Devil | 0.271 |
| **Large Land Mammal** | Moose | ADF&G 2003 Red Devil | 0.076[1] |
| **Small Land Mammals** | Beaver | ADF&G 2012 Red Devil | 0.037 |
| **Birds** | Grouse | ADF&G 2012 Red Devil | 0.011 |
| **Berries and Plants** | Blueberry | ADF&G 2012 | 0.014 |

**Notes:**
1 – At the time of the writing of the draft HHRA, the 95th percentile use value was not available. The value presented in this table is based on the mean consumption rate. The value will be updated in the final HHRA, if available.
**Key:**
g/day = grams per day
IR = ingestion rate

**Table 6-23 Arsenic Bioaccessibility at Red Devil Mine**

| Exposure Unit | Sample ID | Arsenic Bioaccessibility (%) <250 µm Sieve |
|---|---|---|
| Background | 11RD18SS | 34.9 |
| Background | 11UP09SS | 68.1 |
| DA | 11RD30SS | 36.1 |
| MPA | 11MP34SS | 2.7 |
| MPA | 11MP59SS | 12.9 |
| MPA | 11MP32SS | 15.2 |
| MPA | 11MP36SS | 19.9 |
| MPA | 11MP52SS | 39.1 |
| MPA | 11MP90SS | 40.4 |
| MPA | 11MP17SS | 40.9 |
| MPA | 11MP25SS | 47.3 |
| SMA | 11SM18SS | 4 |
| SMA | 11SM13SS | 7.6 |
| SMA | 11SM28SS | 43 |

Key:
DA Downstream Alluvial Area
MPA Main Processing Area
SMA Surface Mined Area
µm micrometer

**Table 6-24 Comparison of Modeled and Actual Game Fish Concentrations**

| COPC | Game Fish Modeled EPC | | | Reach C Northern Pike - Muscle | | | | | Reach C Northern Pike - Liver | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | 95% UCL | Units | n | Min | Max | 95% UCL | Units | n | Min | Max | 95% UCL | Units |
| Antimony | 21 | 17.06 | mg/kg-wet | 17 | ND | ND | ND | mg/kg-wet | 17 | ND | ND | ND | mg/kg-wet |
| Arsenic | 21 | 11.40 | mg/kg-wet | 17 | 0.059 | 1.025 | 0.626 | mg/kg-wet | 17 | 0.032 | 0.446 | 0.195 | mg/kg-wet |
| Mercury | 21 | 6.42 | mg/kg-wet | 17 | 0.060 | 0.609 | 0.371 | mg/kg-wet | 17 | 0.050 | 0.414 | 0.186 | mg/kg-wet |

Key:

95% UCL = 95 percent upper confidence limit on the mean
COPC = contaminant of potentical concern
EPC = exposure point concentraiton
Max = maximum detected concentration
mg/kg-wet = milligrams per kilograms wet weight
Min = minimum detected concentration
n = number of samples
ND = not detected

**Table 6-25 Comparison of Total Mercury Concentrations in Blueberry Fruit Data**

| Area | Bailey and Gray, 1997 | | Modeled Blueberry Fruit Concentrations and RI Soil Concentrations |
|---|---|---|---|
| | Range (mg/kg) | | 95 UCL (mg/kg) |
| **Blueberries** | | | |
| Retort (unmined) | 0.030 | 0.100 | 101[1] |
| Mined | 0.040 | 0.060 | 7.89[2] |
| **Soil** | | | |
| Retort (unmined) | 0.2 | 120 | 506[1] |
| Mined | 0.2 | 1200 | 39.4[2] |

Notes:
1 – Used values from MPA.
2 – Used values from SMA.

Key:
RI remedial investigation
mg/kg milligrams per kilogram
UCL upper confidence limit

**Table 6-26. Non-Cancer Toxicity Date - Oral/Dermal**

| Compound of Potential Concern | Oral RfD Value | GI Absorption Factor[(1)] | Adjusted Dermal RfD[(2)] | Units | Primary Target Organ | Sources of RfD: Target Organ | Notes |
|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | |
| Aluminum | 1.0E+00 | 1 | 1.0E+00 | mg/kg-d | Nervous System | PPRTV | |
| Antimony | 4.0E-04 | 0.15 | 6.0E-05 | mg/kg-d | Whole Body | IRIS | |
| Arsenic | 3.0E-04 | 1 | 3.0E-04 | mg/kg-d | Cardiovascular, Skin | IRIS | Surrogate = Arsenic (Inorganic) |
| Arsenic (Inorganic) | 3.0E-04 | 1 | 3.0E-04 | mg/kg-d | Cardiovascular, Skin | IRIS | |
| Barium | 2.0E-01 | 0.07 | 1.4E-02 | mg/kg-d | Kidney | IRIS | |
| Cadmium (Diet) | 1.0E-03 | 0.025 | 2.5E-05 | mg/kg-d | Kidney | IRIS | |
| Cadmium (Water) | 5.0E-04 | 0.05 | 2.5E-05 | mg/kg-d | Kidney | IRIS | |
| Chromium | 1.5E+00 | 0.013 | 2.0E-02 | mg/kg-d | NA | IRIS | Trivalent chromium |
| Cobalt | 3.0E-04 | 1 | 3.0E-04 | mg/kg-d | Hematologic System | PPRTV | |
| Copper | 4.0E-02 | 1 | 4.0E-02 | mg/kg-d | GI Tract | HEAST | |
| Iron | 7.0E-01 | 1 | 7.0E-01 | mg/kg-d | | PPRTV | |
| Manganese | 2.4E-02 | 0.04 | 9.6E-04 | mg/kg-d | Nervous System | IRIS | Non-diet contribution |
| Manganese | 1.4E-01 | 1 | 1.4E-01 | mg/kg-d | Nervous System | IRIS | Diet contribution |
| Mercury | 3.0E-04 | 0.07 | 2.1E-05 | mg/kg-d | Immune System, Nervous System, Kidney | IRIS | Mercuric Chloride (and other Mercury salts) |
| Nickel | 2.0E-02 | 0.04 | 8.0E-04 | mg/kg-d | | IRIS | Soluble salts |
| Selenium | 5.0E-03 | 1 | 5.0E-03 | mg/kg-d | Skin | IRIS | |
| Silver | 5.0E-03 | 0.04 | 2.0E-04 | mg/kg-d | Skin | IRIS | |
| Thallium | 1.0E-05 | 1 | 1.0E-05 | mg/kg-d | Skin | PPRTV | Soluble salts |
| Vanadium | 5.0E-03 | 1 | 5.0E-03 | mg/kg-d | Kidney | IRIS | |
| Zinc | 3.0E-01 | 1 | 3.0E-01 | mg/kg-d | Hematologic System | IRIS | |

**Table 6-26. Non-Cancer Toxicity Date - Oral/Dermal**

| Compound of Potential Concern | Oral RfD Value | GI Absorption Factor(1) | Adjusted Dermal RfD(2) | Units | Primary Target Organ | Sources of RfD: Target Organ | Notes |
|---|---|---|---|---|---|---|---|
| **Organometals** | | | | | | | |
| Methyl mercury | 1.0E-04 | 1 | 1.0E-04 | mg/kg-d | Nervous System, Developmental | IRIS | |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | | |
| 1-Methylnaphthalene | 7.0E-02 | 1 | 7.0E-02 | mg/kg-d | Lung | ATSDR | |
| Naphthalene | 2.0E-02 | 1 | 2.0E-02 | mg/kg-d | Nervous System | IRIS | |
| **Semivolatile Organic Compounds** | | | | | | | |
| Bis(2-Ethylhexyl)phthalate | 2.0E-02 | 1 | 2.0E-02 | mg/kg-d | Reproductive System | IRIS | |

Key:
ATSDR = Agency of Toxic Substances and Disease Registry
GI = gastrointestinal
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/kg-d = milligrams per kilogram per day
N/A = Not Applicable or Not Available.

Notes:
(1) Refer to Risk Assessment Guidance for Superfund, Part E (EPA 2004).
(2) Dermal RfD = Oral RfD x GI Absorption Factor.

**Table 6-27 Non-Cancer Toxicity Date - Inhalation**

| Compound of Potential Concern | Inh. RfC Value | Units | Primary Target Organ | Sources of RfC: Target Organ | Notes |
|---|---|---|---|---|---|
| **Metals** | | | | | |
| Aluminum | 5.0E-03 | $mg/m^3$ | Respiratory | PPRTV | |
| Arsenic | 1.5E-05 | $mg/m^3$ | Skin, Nervous System, Cardiovascular | CalEPA | Surrogate = Arsenic (Inorganic) |
| Arsenic (Inorganic) | 1.5E-05 | $mg/m^3$ | Skin, Nervous System, Cardiovascular | CalEPA | |
| Barium | 5.0E-04 | $mg/m^3$ | Cardiovascular, Reproductive and Developmental | HEAST | |
| Cadmium | 2.0E-05 | $mg/m^3$ | Kidney, Lungs | CalEPA | |
| Cobalt | 6.0E-06 | $mg/m^3$ | | PPRTV | |
| Manganese | 5.0E-05 | $mg/m^3$ | Nervous System, Respiratory, Reproductive | IRIS | |
| Mercury | 3.0E-04 | $mg/m^3$ | Nervous System, Kidney | IRIS | Elemental mercury |
| Nickel | 9.0E-05 | $mg/m^3$ | Respiratory, Immunological | CalEPA | Soluble salts |
| Selenium | 2.0E-02 | $mg/m^3$ | Respiratory, Gastrointestinal, Nervous System | CalEPA | |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | |
| Naphthalene | 3.0E-03 | $mg/m^3$ | Blood, eyes, Gastrointestinal, Nervous System, Liver, Kidney | IRIS | |

Notes:
CalEPA = California Environmental Protection Agency
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/m3 = milligrams per cubic meter
PPRTV = Provisional Peer-Reviewed Toxicity Value

**Table 6-28 Cancer Toxicity Data - Oral/Dermal**

| Compound of Potential Concern | Oral Cancer Slope Factor | GI Absorption Factor(1) | Adjusted Dermal Cancer Slope Factor(2) | Units | Mutagen (Yes/No) | Source | Notes |
|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | |
| Arsenic | 1.5 | 1 | 1.5 | (mg/kg-d)-1 | No | IRIS | Surrogate = Arsenic (Inorganic) |
| Arsenic (Inorganic) | 1.5 | 1 | 1.5 | (mg/kg-d)-1 | No | IRIS | |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | | |
| 1-Methylnaphthalene | 0.029 | 1 | 0.029 | (mg/kg-d)-1 | No | PPRTV | Surrogate = 2-Methylnaphthalene |
| **Semivolatile Organic Compounds** | | | | | | | |
| Bis(2-Ethylhexyl)phthalate | 0.014 | 1 | 0.014 | (mg/kg-d)-1 | No | IRIS | |

IRIS = Integrated Risk Information System.
PPRTV = Provision Peer- Revised Toxicity Values
SF = Slope Factor
mg/kg-d = milligrams per kilograms per day

(1) Refer to Risk Assessment Guidance for Superfund, Part E (EPA 2004).
(2) Dermal SF = Oral SF/GI Absorption factor.

**Table 6-29 Cancer Toxicity Data - Inhalation**

| Compound of Potential Concern | Inalation Unit Risk | Units | Mutagen (Yes/No) | Weight of Evidence/ Cancer Guideline Description | Source | Notes |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Arsenic | 4.30E-03 | (µg/m3)-1 | No | A | IRIS | Surrogate = Arsenic (Inorganic) |
| Arsenic (Inorganic) | 4.30E-03 | (µg/m3)-1 | No | A | IRIS | |
| **Semivolatile Organic Compounds** | | | | | | |
| Bis(2-Ethylhexyl)phthalate | 2.40E-06 | (µg/m3)-1 | No | | CalEPA | |

IRIS = Integrated Risk Information System.
CalEPA = California Environmental Protection Agency
µg/m3 = micrograms per cubic meter

**Table 6-30 Summary of Excess Lifetime Cancer Risks for Red Devil Mine**

| Medium | Exposure Route | Future Resident - Surface Mined Area | Future Resident - Main Processing Area | Future Resident - RDC Downstream Alluvial Area | Recreational/ Subsistence User | Mine Worker |
|---|---|---|---|---|---|---|
| HI By Target Organ | | | | | | |
| | Ingestion | 6E-03 | 8E-03 | 4E-03 | 2E-03 | 2E-03 |
| Soil | Dermal | 1E-03 | 1E-03 | 6E-04 | 3E-04 | 5E-04 |
| Sediment | Dermal | 3E-03 | 3E-03 | 3E-03 | 3E-03 | 2E-03 |
| | Ingestion | 9E-04 | 4E-02 | 4E-02 | -- | 2E-02 |
| Groundwate | Dermal | 2E-06 | 9E-05 | 9E-05 | -- | 7E-05 |
| | Ingestion | -- | -- | -- | 7E-04 | -- |
| Surface Wat | Dermal | 7E-06 | 7E-06 | 7E-06 | 2E-06 | 5E-06 |
| Air | Inhalation of Fugitive Dust/Volatiles from Soil | 7E-06 | 9E-06 | 4E-06 | 5E-07 | 7E-06 |
| Fish | Ingestion | 4E-03 | 4E-03 | 4E-03 | 7E-04 | 4E-04 |
| Large Land | Ingestion | 2E-05 | 2E-05 | 2E-05 | 3E-07 | 2E-07 |
| Small Land | Ingestion | 2E-04 | 2E-04 | 2E-04 | 5E-06 | 2E-06 |
| Birds | Ingestion | 9E-04 | 9E-04 | 9E-04 | 3E-04 | 2E-04 |
| Berries and | Ingestion | 6E-03 | 8E-03 | 3E-03 | 6E-05 | 3E-05 |
| **otal Excess Lifetime Cancer Risk** | | **2E-02** | **7E-02** | **6E-02** | **8E-03** | **3E-02** |

Shaded cell indicates excess lifetime cancer risk greater than $10^{-5}$.

**Table 6-31 Summary of Hazard Indices for Red Devil Mine**

| Medium | Exposure Route | Future Resident - Surface Mined Area | | Future Resident - Main Processing Area | | Future Resident - RDC Downstream Alluvial Area | | Recreational/ Subsistence User | | Mine Worker |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Adult | Child | Adult | Child | Adult | Child | Adult | Child | Adult |
| HI By Target Organ | | | | | | | | | | |
| | Ingestion | 12 | 116 | 30 | 284 | 10 | 94 | 8 | 74 | 22 |
| Soil | Dermal | 2.4 | 16 | 3.3 | 22 | 1.4 | 9.4 | 0.8 | 5.4 | 3.8 |
| Sediment | Dermal | 8 | 55 | 8 | 55 | 8 | 55 | 8 | 55 | 14 |
| | Ingestion | 6 | 13 | 554 | 1293 | 554 | 1293 | -- | -- | 396 |
| Groundwate | Dermal | 0.1 | 0.1 | 6.3 | 1.3 | 6.3 | 1.3 | -- | -- | 4.5 |
| | Ingestion | -- | -- | -- | -- | -- | -- | 0.0 | 0.0 | -- |
| Surface Wat | Dermal | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.0 | 0.1 | 0.0 |
| | Inhalation of Fugitive Dust/Volatiles from Soil | 4.6 | 4.6 | 56 | 56 | 18 | 18 | 14 | 14 | 13 |
| Air | Inhalation of Volatiles from Groundwater | 0.0 | 0.0 | 0.7 | 0.7 | 0.7 | 0.7 | -- | -- | -- |
| Fish | Ingestion | 432 | 967 | 432 | 967 | 432 | 967 | 86 | 193 | 59 |
| Large Land | Ingestion | 8 | 18 | 8 | 18 | 8 | 18 | 0 | 0 | 0 |
| Small Land | Ingestion | 10 | 21 | 10 | 21 | 10 | 21 | 0 | 0 | 0 |
| Birds | Ingestion | 16 | 37 | 16 | 37 | 16 | 37 | 5.4 | 12 | 3.7 |
| Berries and | Ingestion | 29 | 66 | 170 | 381 | 48 | 108 | 1.3 | 3.0 | 0.1 |
| **Total Hazard Index** | | 529 | 1314 | 1295 | 3136 | 1113 | 2623 | 124 | 358 | 517 |

Shaded cell indicates HI greater than 1.0.

### Table 6-32 Summary of Excess Lifetime Cancer Risks for Background

| Medium | Exposure Route | Future Resident | Recreational/ Subsistence User | Mine Worker |
|---|---|---|---|---|
| Soil | Ingestion | 4E-04 | 1E-04 | 1E-04 |
| | Dermal | 6E-05 | 2E-05 | 3E-05 |
| Sediment | Dermal | 9E-06 | 3E-06 | 4E-06 |
| Groundwater | Ingestion | 3E-04 | -- | 2E-04 |
| | Dermal | 7E-07 | -- | 5E-07 |
| Surface Water | Ingestion | -- | 7E-04 | -- |
| | Dermal | 1E-08 | 2E-06 | 7E-09 |
| Air | Inhalation of Fugitive Dust/Volatiles from Soil | 4E-07 | 3E-08 | 4E-07 |
| Fish | Ingestion | 0E+00 | 0E+00 | 0E+00 |
| Large Land Mammals | Ingestion | 5E-06 | 7E-08 | 4E-08 |
| Small Land Mammals | Ingestion | 4E-05 | 8E-07 | 5E-07 |
| Birds | Ingestion | 1E-05 | 5E-06 | 2E-06 |
| Berries and Plants | Ingestion | 4E-04 | 4E-06 | 2E-06 |
| **Total Excess Lifetime Cancer Risk** | | **1E-03** | **9E-04** | **3E-04** |

Note:

Shaded cell indicates excess lifetime cancer risk greater than $10^{-5}$.

### Table 6-33 Summary of Hazard Indices for Background

| Medium | Exposure Route | Future Resident - Background | |
|---|---|---|---|
| | | Adult | Child |
| Soil | Ingestion | 0.9 | 8.8 |
| | Dermal | 0.2 | 1.0 |
| Sediment | Dermal | 0.0 | 0.1 |
| Groundwater | Ingestion | 8.0 | 18.6 |
| | Dermal | 0.2 | 0.5 |
| Surface Water | Ingestion | -- | -- |
| | Dermal | 0.0 | 0.0 |
| Air | Inhalation of Fugitive Dust/Volatiles from Soil | 0.2 | 0.2 |
| | Inhalation of Volatiles from Groundwater | 0.7 | 0.7 |
| Fish | Ingestion | 0.0 | 0.0 |
| Large Land Mammals | Ingestion | 0.0 | 0.0 |
| Small Land Mammals | Ingestion | 1.6 | 3.5 |
| Birds | Ingestion | 2.8 | 6.2 |
| Berries and Plants | Ingestion | 2.0 | 4.4 |
| **Total Hazard Index** | | 16.7 | 44.3 |

Note:
Shaded cell indicates HI greater than 1.0.

## Table 6-34 Human Health Risk Assessment Uncertainties

| Area of Uncertainty | Potential Impact on Risk |
|---|---|
| **Environmental Sampling and Analysis** | |
| Targeted sampling | Overestimate |
| Background characterization | Over- or Underestimate |
| Detection limits in water above RBSC | Underestimate |
| **Exposure Point Concentrations** | |
| Inclusion of estimated results | Overestimate |
| Inclusion of non-detected chemicals in EPC calculation | Over- or Underestimate |
| Use of 95 UCL or maximum concentration | Overestimate |
| Exclusion of non-detected chemicals | Underestimate |
| Modeled COPC concentrations in tissue | Overestimate |
| Use of total mercury results to estimate volatile, elemental mercury in soil and water | Overestimate |
| Use of total metal concentrations in groundwater | Overestimate |
| **Exposure Assessment** | |
| Change in chemical concentrations not considered | Over- or Underestimate |
| Use of high end and default values | Overestimate |
| Dermal exposure to sediment | Over- or Underestimate |
| Wild food ingestion rates based on harvest data | Overestimate |
| Fraction of wild food ingested from site | Overestimate |
| Use of representative species | Over- or Underestimate |
| Bioaccessibility of arsenic and other metals | Overestimate |
| **Toxicity Assessment** | |
| Determination of toxicity values | Over- or Underestimate |
| Dermal toxicity values | Over- or Underestimate |
| Assumption of additive impacts | Overestimate |
| Not including synergistic effects | Underestimate |
| Use of surrogates | Over- or Underestimate |
| Use of lead models | Over- or Underestimate |
| **Risk Characterization** | |
| Not including preparation of food | Over- or Underestimate |
| Background risks and hazards not included | Overestimate |
| Exclusion of telemetry data for fish | Overestimate |

Key:
COPC contaminants of particular concern
EPC exposure point concentration
RBSC risk-based screening concentrations
UCL upper confidence limit

## Table 6-35 Summary of Chemical and Endpoint Combinations to be Evaluated in the Baseline Ecological Risk Assessment, Red Devil Mine Site

| Analyte[b] | Assessment Endpoint and Maximum HQ from Revised SLERA[a] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Terrestrial Wildlife[h] | | | | | | Aquatic-Dependent Wildlife[i] | | | | |
| | Plants[c] | Soil Fauna[d] | Fish and Other Aquatic Biota[e] | Fish[f] | Benthos[g] | Robin | Shrew | Grouse | Vole | Shrike | Weasel | Snipe | Beaver | Teal | Kingfisher | Mink |
| **Polychlorinated Biphenyls (PCBs)** | | | | | | | | | | | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | | x | | | | | | | | | | | | | | |
| **Metals** | | | | | | | | | | | | | | | | |
| Antimony | x | 299 | 6.1 | x | 2,193 | x | **136,370** | x | **1,681** | x | | x | **60** | x | x | **89** |
| Arsenic | 549 | x | 6.9 | 14 | 13,265 | **28** | **214** | **47** | **41** | **1.5** | **1.9** | **823** | **1.5** | **37** | **5.5** | **3.3** |
| Barium | x | 5.2 | 26 | x | x | **2.0** | **1.6** | **1.3** | | | | **1.4** | | | | |
| Beryllium | x | | | | x | x | | x | | x | | x | | x | x | |
| Cadmium | | | | | | **1.7** | **4.4** | | | | | | | | | |
| Chromium | 1.3 | x | | 3.5 | 1.1 | **2.9** | **1.3** | | | | | | | | | |
| Cobalt | 3.0 | x | | | 1.0 | | | | | | | | | | **1.1** | |
| Copper | 2.0 | 1.7 | | | 2.8 | **4.4** | **4.6** | | | | | **1.5** | | | | |
| Iron | | | 2.5 | | 16 | | | | | | | | | | | |
| Lead | 26 | 1.8 | | | | **83** | **48** | **20** | **2.8** | **4.9** | **1.0** | | | | | |
| Manganese | 19 | 9.4 | 3.2 | x | 12 | | **2.3** | **2.1** | **6.1** | | | | | | | |
| Mercury | 5,400 | 16,200 | 32 | 8 | 661 | **9.5** | **2.1** | **39** | | | | **5.8** | | **2.8** | **4.2** | |
| Methylmercury | | | | 1 | x | | | | | | | | | | **2.3** | **1.3** |
| Nickel | 2.6 | | | | 11 | **3.7** | **21** | | | | | | | | | |
| Selenium | | | | 2.7 | | | **1.2** | | | | | **5.7** | | | **5.2** | **2.9** |
| Silver | | x | | | | | | | | | | | | | | |
| Thallium | | x | | | x | x | **3.3** | x | | x | | x | | x | x | **3.8** |
| Vanadium | 26 | x | | x | x | **1.9** | | **1.7** | | | | **2.5** | | | | |
| Zinc | 2.4 | 3.2 | | 1.3 | 1.1 | **2.2** | **2.7** | | | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | | | | | | | | | | | |
| HPAH sum | | | | | | | | | | | | | | | | |
| LPAH sum | | | | | | x | | x | | x | | x | | | x | |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | | | | | | | | | | | |
| 4-Bromophenyl phenyl ether | x | x | | | | x | x | x | x | x | x | | x | | | |
| 4-Methylphenol | x | x | | | | x | | x | | x | | | | | | |
| Benzoic acid | x | x | | | | x | x | x | x | x | x | | x | | | |
| Benzyl Alcohol | x | x | | | | x | x | x | x | x | x | x | x | | x | x |
| Bis(2-Ethylhexyl)phthalate | x | x | | | | | | | | | | | | | | |
| Dibenzofuran | | | | | | x | x | x | x | x | x | | x | | | |
| Diethylphthalate | | x | | | | x | | x | | x | | x | | | x | |

## Table 6-35 Summary of Chemical and Endpoint Combinations to be Evaluated in the Baseline Ecological Risk Assessment, Red Devil Mine Site

| Analyte[b] | Assessment Endpoint and Maximum HQ from Revised SLERA[a] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Terrestrial Wildlife[h] | | | | | | Aquatic-Dependent Wildlife[i] | | | | |
| | Plants[c] | Soil Fauna[d] | Fish and Other Aquatic Biota[e] | Fish[f] | Benthos[g] | Robin | Shrew | Grouse | Vole | Shrike | Weasel | Snipe | Beaver | Teal | Kingfisher | Mink |
| Dimethylphthalate | x | | | | | x | x | x | x | x | x | | x | | | |
| Di-n-butyl Phthalate | | | | | | | | | | | | | | | | |
| Hexachlorobenzene | x | | | | | | | | | | | | | | | |
| Pentachlorophenol | | | | | | | | | | | | | | | | |
| Phenol | | | | | | | | | | | | | | | | |

Key:
BERA = Baseline Ecological Risk Assessment
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
SLERA = screening level ecological risk assessment (Appendix G in draft RI report)
TRV = toxicity reference value
Value (with or without shading) = HQ equal to or greater than 1. Chemical and receptor combination will be evaluated quantitatively in the BERA.
x = chemical detected in site samples but no screening level or TRV is available. Chemical will be evaluated qualitatively in the BERA.

Notes:
a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):

Value = > 75%
Vaue = 50 - 75%
Value = 25 - 50%
Value = < 25%

For wildlife, the value of the maximum HQ (exposure estimate / TRV) is shown without shading because wildlife HQs were not calculated sample-by-sample.

b. Essential nutrients (calcium, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003a). Organic chemicals detected in surface soil, sediment, or surface water are listed.

c. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on plants (see SLERA Table 4-1).

d. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on earthworms (see SLERA Table 4-1).

e. Based on comparing maximum surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see SLERA Table 4-3).

f. Based on comparing maximum whole-body scuplin chemical concentrations with fish tissue screening concentrations (see SLERA Table 4-3b).

g. Based on comparing maximum sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see SLERA Table 4-2).

h. Based on screening-level exposure estimates and hazard quotients for the American robin (SLERA Table 4-15), masked shrew (SLERA Table 4-16), spruce grouse (SLERA Table 4-17), tundra vole (SLERA Table 4-18), northern shrike (SLERA Table 4-19), and least weasel (SLERA Table 4-20).

i. Based on screening-level exposure estimates and HQs for the common snipe (SLERA Table 4-21), beaver (SLERA Table 4-22), green-winged teal (SLERA Table 4-23), belted kingfisher (SLERA Table 4-24), and mink (SLERA Table 4-25).

**Table 6-36 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.**

| Assessment Endpoint | Risk Question | Indicator Species | Measure for BERA | Assessment Method | Include in BERA? |
|---|---|---|---|---|---|
| **Primary Producers** | | | | | |
| Terrestrial plant species abundance, diversity, and primary production. | Are levels of contaminants in surface soil from the site great enough to affect terrestrial plant survival, growth, or reproduction? | All plants that obtain nutrients primarily from soil. | Chemical concentrations in soils. | Compare soil chemical concentration with phytotoxicity benchmarks. | Yes |
| **Herbivores and Detritivores** | | | | | |
| Freshwater aquatic invertebrate community abundance and diversity. | Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater aquatic invertebrates? | All freshwater aquatic invertebrates. | Chemical concentrations in surface water. | Compare surface water chemical concentration with chronic, freshwater quality criteria | Yes |
| Freshwater benthic invertebrate community abundance and diversity. | Are levels of contaminants in sediment from Red Devil Creek great enough to affect survival, growth, or reproduction of benthic invertebrates? | All freshwater benthic invertebrates. | 1. Chemical concentrations in sediment.<br><br>2. Results from benthic macroinvertebrate surveys in Red Devil Creek and nearby reference creeks. | Compare sediment chemical concentration with sediment quality benchmark. | Yes |
| Soil invertebrate community abundance and diversity. | Are levels of contaminants in site soils great enough to affect survival, growth, or reproduction of soil invertebrates? | All terrestrial invertebrates. | Chemical concentrations in soil. | Compare soil chemical concentration with available toxicity benchmarks for earthworms or other soil invertebrates. | Yes |

**Table 6-36 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.**

| Assessment Endpoint | Risk Question | Indicator Species | Measure for BERA | Assessment Method | Include in BERA? |
|---|---|---|---|---|---|
| Freshwater fish detritivore abundance and diversity. | Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater fish? | All freshwater fish. | Chemical concentrations in surface water. | Compare surface water chemical concentration with chronic, freshwater quality criteria. | Yes |
| Freshwater semi-aquatic avian herbivore abundance and diversity. | Does the daily dose of chemicals received by herbivorous waterfowl from consumption of semi-aquatic plants and other media in the settling ponds at the RDM site exceed TRVs for survival, growth or reproduction of birds? | Green-winged teal[a] | 1. Chemical concentrations in settling pond sediment (dry at time of sampling).<br><br>2. Chemical concentrations in settling pond surface water.<br><br>3. Chemical concentrations in semi-aquatic plants growing in the settling ponds. | Modeled chemical dose from ingestion of semi-aquatic plants, water, and sediment compared with TRV. | Yes. According to Alaska DEC, signs of waterfowl use of the settling ponds near the main processing area have been reported. |
| Terrestrial avian herbivore abundance and diversity. | Does the daily dose of chemicals received by herbivorous birds from consumption of terrestrial plants and other media at the site exceed TRVs for survival, growth or reproduction of birds? | Spruce grouse[a] | 1. Chemical concentrations in soil.<br><br>2. Chemical concentrations in surface water.<br><br>3. Chemical concentrations in conifer needles. | Modeled chemical dose from ingestion of terrestrial plants, water, and soil compared with TRV. | Yes. Spruce grouse are known to use the site and are hunted by residents of Red Devil Village. |

**Table 6-36 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.**

| Assessment Endpoint | Risk Question | Indicator Species | Measure for BERA | Assessment Method | Include in BERA? |
|---|---|---|---|---|---|
| Freshwater mammalian semi-aquatic mammalian herbivore abundance and diversity. | Does the daily dose of chemicals received by herbivorous mammals from consumption of semi-aquatic and terrestrial plants and other media at the site exceed TRVs for survival, growth or reproduction of mammals? | Beaver[a] | 1. Chemical concentrations in soil.<br><br>2. Chemical concentrations in surface water.<br><br>3. Chemical concentrations in green alder bark. | Modeled chemical dose from ingestion of plants, water, and soil compared with TRV. | Yes. Historic use of Red Devil Creek by beavers is evident. |
| Terrestrial mammalian herbivore abundance and diversity. | Does the daily dose of chemicals received by herbivorous mammals from consumption of terrestrial plants and other media at the site exceed TRVs for survival, growth or reproduction of mammals? | Tundra vole. | 1. Chemical concentrations in soil.<br><br>2. Chemical concentrations in surface water.<br><br>3. Chemical concentrations in a representative herbaceous plant (blueberry stems and leaves). | Modeled chemical dose from ingestion of terrestrial plants, water, and soil compared with TRV. | Yes |
| **Secondary Consumers** | | | | | |
| Semi-aquatic avian invertivore abundance and diversity. | Does the daily dose of chemicals received by semi-aquatic birds from consumption of benthic invertebrates and other media from Red Devil Creek exceed TRVs for survival, growth or reproduction of birds? | Common snipe. | 1. Chemical concentrations in sediment.<br><br>2. Chemical concentrations in surface water.<br><br>3. Chemical concentrations in benthic invertebrates. | Modeled chemical dose from ingestion of benthic invertebrates, surface water, and sediment compared with TRV. | Yes |

**Table 6-36 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.**

| Assessment Endpoint | Risk Question | Indicator Species | Measure for BERA | Assessment Method | Include in BERA? |
|---|---|---|---|---|---|
| Terrestrial avian invertivore abundance and diversity. | Does the daily dose of chemicals received by invertivorous birds from consumption of terrestrial invertebrates and other media from the site exceed TRVs for survival, growth or reproduction of birds? | American robin. | 1. Chemical concentrations in soil.<br><br>2. Chemical concentrations in surface water. | Modeled chemical dose from ingestion of soil invertebrates, surface water, and soil compared with TRV. | Yes |
| Freshwater fish invertivore abundance and diversity. | Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater fish? | All freshwater fish. | Chemical concentrations in surface water. | Compare surface water chemical concentration with chronic, freshwater quality criteria | Yes |
| Freshwater amphibian invertivore abundance and diversity. | Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of amphibians? | Wood frog. | Chemical concentrations in surface water. | Compare surface water chemical concentration with chronic, freshwater quality criteria. | Yes. Wood frogs have not been observed at the site, but their possible presence cannot be ruled out. |
| Terrestrial mammalian invertivore abundance and diversity. | Does the daily dose of chemicals received by invertivorous mammals from consumption of terrestrial invertebrates and other media from the site exceed TRVs for survival, growth, or reproduction of mammals? | Masked shrew. | 1. Chemical concentrations in soil.<br><br>2. Chemical concentrations in surface water. | Modeled chemical dose from ingestion of soil invertebrates, surface water, and soil compared with TRV. | Yes |

**Table 6-36 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.**

| Assessment Endpoint | Risk Question | Indicator Species | Measure for BERA | Assessment Method | Include in BERA? |
|---|---|---|---|---|---|
| **Tertiary Consumers** | | | | | |
| Freshwater avian piscivore abundance and diversity | Does the daily dose of chemicals received by piscivorous birds from consumption of fish and other media from Red Devil Creek exceed TRVs for survival, growth, or reproduction of birds? | Belted kingfisher. | 1. Chemical concentrations in surface water.<br><br>2. Chemical concentrations in fish. | Modeled chemical dose from ingestion of fish and water compared with TRV | Yes |
| Terrestrial avian carnivore abundance and diversity | Does the daily dose of chemicals received by carnivorous birds from consumption of small mammals and other media from the site exceed TRVs for survival, growth or reproduction of birds? | Northern shrike. | 1. Chemical concentrations in soil.<br><br>2. Chemical concentrations in surface water. | Modeled chemical dose from ingestion of prey compared with TRV | Yes |
| Terrestrial mammalian carnivore abundance and diversity | Does the daily dose of chemicals received by carnivorous mammals from consumption of prey and other media from the site exceed TRVs for survival, growth, or reproduction of mammals? | Least weasel. | 1. Chemical concentrations in soil.<br><br>2. Chemical concentrations in surface water. | Modeled chemical dose from ingestion of prey, surface water, and soil compared with TRV. | Yes |

**Table 6-36 Assessment Endpoints, Risk Questions, Indicator Species, Measures, and Assessment Methods for the Red Devil Mine Site BERA.**

| Assessment Endpoint | Risk Question | Indicator Species | Measure for BERA | Assessment Method | Include in BERA? |
|---|---|---|---|---|---|
| Freshwater mammalian carnivore abundance and diversity | Does the daily dose of chemicals received by piscivorous mammals from consumption of fish and other media from Red Devil Creek exceed TRVs for survival, growth or reproduction of mammals? | Mink. | 1. Chemical concentrations in surface water.<br><br>2. Chemical concentrations in fish. | Modeled chemical dose from ingestion of fish and sediment compared with TRV. | Yes |
| Freshwater fish piscivore abundance and diversity | Are levels of contaminants in surface water from Red Devil Creek great enough to affect survival, growth, or reproduction of freshwater fish? | All freshwater fish. | 1. Chemical concentrations in surface water. | Compare surface water chemical concentration with chronic, freshwater quality criteria. | Yes |

Key:
ADEC = Alaska Department of Environmental Conservation
BERA = Baseline ecological risk assessment
RDM = Red Devil Mine
TRV = Toxicity reference value

Note:
a = Differs from primary indicator species recommended by ADEC (1999) for site-specific reasons.

## Table 6-37 Exposure Assessment and Risk Characterization for Terrestrial Plants and Soil Invertebrates Based on Surface Soil (0 to 2 feet bgs) Data, Red Devil Mine Site BERA

| | | | | | | Soil Ecological Screening Levels and Hazard Quotients | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Plants | | | | | Soil Invertebrates | | | | |
| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | EPC[c] | FoD | Value[d] | FoE | HQ[f] | COC | Rationale[g] | Value[e] | FoE | HQ[f] | COC | Rationale[g] |
| **Metals (mg/kg)** | | | | | | | | | | | | | | | |
| Antimony | 135 | 0.708 J | 23300 J | 4,234 | 111/135 | -- | -- | -- | Yes | NSL | 78 | 86/135 | 54 | Yes | >SL |
| Arsenic | 135 | 9 | 9880 | 3,569 | 134/135 | 18 | 126/134 | 198 | Yes | >SL | -- | -- | -- | Yes | NSL |
| Barium | 135 | 76.2 | 1710 | 438 | 135/135 | -- | -- | -- | Yes | NSL | 330 | 41/135 | 1.3 | Yes | >SL |
| Beryllium | 135 | 0.3 | 1.3 | 0.73 | 132/135 | -- | -- | -- | Yes | NSL | 40 | 0/1354 | 0.03 | No | <SL |
| Chromium | 135 | 6 | 101 | 29.1 | 135/135 | 75 | 1/135 | 0.39 | No | <SL | -- | -- | -- | Yes | NSL |
| Cobalt | 135 | 5.9 | 38.8 | 18.1 | 135/135 | 13 | 103/135 | 1.4 | Yes | >SL | -- | -- | -- | Yes | NSL |
| Copper | 135 | 17 | 139 | 69.0 | 135/135 | 70 | 56/135 | 0.99 | No | <SL | 80 | 30/135 | 0.86 | No | <SL |
| Lead | 135 | 5 | 3090 | 96.6 | 126/135 | 120 | 6/126 | 0.80 | No | <SL | 1700 | 1/135 | 0.06 | No | <SL |
| Manganese | 135 | 153 | 4230 | 757 | 135/135 | 220 | 133/135 | 3.4 | Yes | >SL | 450 | 111/135 | 1.7 | Yes | >SL |
| Mercury | 135 | 0.05 J | 1620 | 252 | 135/135 | 0.3 | 126/135 | 839 | Yes | >SL | 0.1 | 133/135 | 2516 | Yes | >SL |
| Methylmercury | 0 | -- | -- | -- | 0/0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Nickel | 135 | 18 | 97 | 52.4 | 135/135 | 38 | 101/135 | 1.4 | Yes | >SL | 280 | 0/135 | 0.35 | No | <SL |
| Silver | 135 | 0.068 | 0.123 | 0.12 | 2/135 | 560 | 0/2 | 0.0002 | No | <SL | -- | -- | -- | Yes | NSL |
| Thallium | 135 | 0.065 | 0.071 | 0.071 | 2/135 | 1 | 0/135 | 0.07 | No | <SL | -- | -- | -- | Yes | NSL |
| Vanadium | 135 | 15.3 | 51.9 | 34.8 | 135/135 | 2 | 135/135 | 17.4 | Yes | >SL | -- | -- | -- | Yes | NSL |
| Zinc | 135 | 38 | 386 | 111 | 135/135 | 160 | 4/135 | 0.69 | No | <SL | 120 | 35/135 | 0.9 | No | <SL |

Key:
-- = not available or not applicable
BERA = Baseline ecological risk assessment
bgs = below ground surface
COC = chemical of concern
COPC = chemical of potential concern
Eco-SSL = Ecological Soil Screening Level
EPC = Exposure point concentration
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence (number of detects > screening level / number of detects)
HQ = hazard quotient
J = estimated value
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
SL = Screening level
SLERA = screening level ecological risk assessment
Shading = HQ equals or exceeds 1, or no SL available. Chemical is a COC.

Notes:
a = Only metals identified and COPCs in the SLERA are listed.
b = 127 original site samples and 8 field duplicate samples.
c = See Appendix H for method of calculation.
d = Eco-SSLs (www.epa.gov/ecotox/ecossl/) for arsenic, cobalt, copper, lead, manganese, nickel, silver, and zinc. Chromium plant screening level is from Alloway (1990). Other plant screening levels are from Efroymson et al. (1997a).
e = Eco-SSLs (www.epa.gov/ecotox/ecossl/).
f = Hazard quotient (EPC divided by screening level)
g = Rationale codes.
For Yes: >SL = EPC exceeds screening level
NSL = no screening level available.
For No: < SLs = EPC less than screening levels

**Table 6-38 Exposure Assessment and Risk Characterization for Benthic Macroinvertebrates in Red Devil Creek and Kuskokwim River Based on Sediment Data, RDM Site BERA**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | EPC[c] | FoD | Sediment Ecological Screening Levels | | FoE | HQ[d] | COC | Rationale[e] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Value | Basis | | | | |
| **Metals (mg/kg)** | | | | | | | | | | | |
| Antimony | 45 | 0.237 J | 6360 J | 2871 | 40/45 | 2.9 | MacDonald et al. (1999). PAETA, WA | 37/40 | 990 | Yes | >SL |
| Arsenic | 45 | 0.57 J | 130000 | 22968 | 45/45 | 33 | MacDonald et al. (2000). PEC. | 33/45 | 696 | Yes | >SL |
| Barium | 45 | 4.12 | 1990 | 474.1 | 45/45 | -- | -- | -- | -- | Yes | NSL |
| Beryllium | 45 | 0.008 J | 0.9 | 1.316 | 43/45 | -- | -- | -- | -- | Yes | NSL |
| Chromium | 45 | 0.65 J | 47.4 J | 22.6 | 43/45 | 111 | MacDonald et al. (2000). PEC. | 0/43 | 0.20 | No | <SL |
| Cobalt | 45 | 0.369 | 50 | 17.7 | 45/45 | 50 | MacDonald et al. (1999). Criterion, Ontario. | 0/45 | 0.35 | No | <SL |
| Copper | 45 | 0.68 | 87.5 | 41.19 | 45/45 | 149 | MacDonald et al. (2000). PEC. | 0/45 | 0.3 | No | <SL |
| Iron | 45 | 19600 | 344000 | 51,808 | 45/45 | 21,200 | MacDonald et al. (1999). LEL, B.C. | 43/45 | 2.4 | Yes | >SL |
| Manganese | 45 | 404 | 5410 | 1256 | 45/45 | 460 | MacDonald et al. (1999). LEL, B.C. | 42/45 | 2.7 | Yes | >SL |
| Mercury | 45 | 0.169 J | 119 J | 36.1 | 45/45 | 1.06 | MacDonald et al. (2000). PEC. | 32/45 | 34 | Yes | >SL |
| Methylmercury | 33 | 0.0001 J | 0.0144 J | 0.0045 | 32/33 | -- | -- | -- | -- | Yes | NSL |
| Nickel | 45 | 0.78 | 240 J | 63.3 | 45/45 | 48.6 | MacDonald et al. (2000). PEC. | 11/45 | 1.3 | Yes | >SL |
| Thallium | 45 | 0.011 J | 0.653 | 0.185 | 29/45 | -- | -- | -- | -- | Yes | NSL |
| Vanadium | 45 | 1.72 | 48.5 | 27.53 | 43/45 | -- | -- | -- | -- | Yes | NSL |
| Zinc | 45 | 1.2 J | 132 J | 95.9 | 45/45 | 459 | MacDonald et al. (2000). PEC. | 0/45 | 0.2 | No | <SL |

Key:
-- = Not available or not applicable
BERA = Baseline ecological risk assessment
B.C. = British Columbia, Canada
COC = Chemical of concern
COPC = Chemical of potential concern
EPC = Exposure point concentration
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
J = estimated value
PAETA = Probable apparent effect threshold approach
PEC = Probable effect concentration
RDM = Red Devil Mine
SL = Screening level
SLERA = Screening level ecological risk assessment
WA = Washington State
[shaded] = HQ equals or exceeds 1, or no SL available. Chemical is a COC.

Notes:
a = Only metals identified and COPCs in the SLERA are listed.
b = 42 original samples and 3 field duplicates
c = See Appendix H for method of calculation.
d = Hazard quotient (EPC / screening level)
e = Rationale codes.
For Yes: >SL = EPC exceeds screening level
=SL = EPC equals screening level
NSL = no screening level available.
For No: <SL = EPC less than screening level

## Table 6-39 Exposure Assessment and Risk Characterization for Fish and other Aquatic Organisms in Red Devil Creek Based on Surface Water Data, Red Devil Mine Site BERA

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | EPC[c] | FoD | Surface Water Chronic Ecological Screening Levels | | FoE | HQ[d] | COC | Rationale[e] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Value | Basis | | | | |
| **Metals (µg/L)** | | | | | | | | | | | |
| Antimony | 22 | 1.3 | 184 | 135.5 | 22/22 | 30 | Suter and Tsao (1996), Tier II SCV | 12/22 | 4.5 | Yes | >SL |
| Arsenic | 22 | 0.8 | 1030 | 811.3 | 22/22 | 150 | ADEC (2008) and USEPA(2009) | 2/22 | 5.4 | Yes | >SL |
| Arsenic (without RD05)[f] | 20 | 0.8 | 85.6 | 85.6 | 20/20 | 150 | ADEC (2008) and USEPA(2009) | 0/22 | 0.57 | No | <SL |
| Barium | 22 | 20.6 | 103 | 43.71 | 22/22 | 4 | Suter and Tsao (1996), Tier II SCV | 22/22 | 10.9 | Yes | >SL |
| Iron | 22 | 118 | 2470 | 1325 | 22/22 | 1,000 | ADEC (2008) and USEPA(2009) | 3/22 | 1.3 | Yes | >SL |
| Iron (without RD05)[f] | 20 | 118 | 2470 | 892 | 20/20 | 1,000 | ADEC (2008) and USEPA(2009) | 1/20 | 0.89 | No | <SL |
| Manganese | 22 | 11.2 | 379 | 170.6 | 22/22 | 120 | Suter and Tsao (1996), Tier II SCV | 2/22 | 1.4 | Yes | >SL |
| Manganese (without RD05)[f] | 20 | 11.2 | 86.4 | 33.2 | 20/20 | 120 | Suter and Tsao (1996), Tier II SCV | 0/22 | 0.28 | No | <SL |
| Mercury | 21 | 0.00192 | 0.385 | 0.243 | 21/21 | 0.77 | ADEC (2008) and USEPA(2009) | 0/21 | 0.31 | No | <SL |
| Mercury | 21 | 0.00192 | 0.385 | 0.243 | 21/21 | 0.012 | USEPA (1986)[g] | 15/21 | 20.2 | Yes | >SL |

Key:
-- = Not available or not applicable
ADEC = Alaska Department of Environmental Conservation
BERA = baseline ecological risk assessment
B.C. = British Columbia
COC = chemical of concern
COPC = chemical of potential concern
EPC = Exposure point concentration
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
SCV = secondary chronic value
SL = screening level
SLERA = screening level ecological risk assessment
USEPA = United States Environmental Protection Agency
[grey shading] = HQ equals or exceeds 1. Chemical is a COC.

Notes:
a = Only metals identified and COPCs in the SLERA are listed.
b = 19 original samples and 3 field duplicates.
c = See Appendix H for method of calculation.
d = Hazard quotient (EPC / screening level).
e = Rationale codes.
For Yes: >SL = EPC exceeds screening level
NSL = no screening level available.
For No: <SL = EPC less than screening level.
f = Excluding the two samples (10RD05SW and 11RD05SW) collected from the spring in the Main Processing Area.
g = Criterion derived using a bioconcentration factor of 81,700 for methylmercury for fathead minnow. Assumes all mercury present in water is methylmercury.

**Table 6-40 Exposure Assessment and Risk Characterization for Fish in Red Devil Creek Based on Comparing Metals in Whole-Body Sculpin Samples With Fish Tissue Sceening Concentrations**

| Analyte[a] | Maximum Detected Concentration (mg/kg wet weight)[b] | Tissue Screening Concentration (mg/kg wet weight)[c] | EPC[d] | FoE | HQ[e] | COPC | Rationale[f] |
|---|---|---|---|---|---|---|---|
| Antimony | 38.1 | -- | 17.1 | -- | -- | Yes | NSL |
| Arsenic | 24.1 | 1.7 | 11.4 | 18/21 | 6.7 | Yes | >SL |
| Barium | 5.40 | -- | 3.8 | -- | -- | Yes | NSL |
| Chromium | 2.43 | 0.69 | 0.68 | 1/21 | 0.99 | No | <SL |
| Manganese | 21.3 | -- | 12.5 | -- | -- | Yes | NSL |
| Mercury | 3.70 | 0.46 | 2.1 | 13/21 | 4.7 | Yes | >SL |
| Methylmercury | 0.312 | 0.3 - 0.7 | 0.312 | 1/2 | 1.0 | Yes | =SL |
| Selenium | 2.98 | 1.1 | 1.89 | 16/21 | 1.7 | Yes | >SL |
| Vanadium | 0.40 | -- | 0.22 | -- | -- | Yes | NSL |
| Zinc | 35.4 | 27 | 26.6 | 7/21 | 0.99 | No | <SL |

Key:
-- not available or not applicable.
EPC = exposure point concentration
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
HQ = hazard quotient
SL = screening level
SLERA = screening level ecological risk assessment

Notes:
a = Only metals identified as COPCs in the SLERA are listed.
b = See Table 6-43
c = Dyer et al. (2000), except for methylmercury, which is from Sandheinrich and Weiner (2011).
d = See Appendix H for method of calculation.
e = Hazard quotient (EPC / screening level)
f = Rationale codes.
For Yes: >SL = EPC exceeds SL
= SL = EPC equals SL
NSL = no screening level available.
For No: <SL = EPC less than SL

## Table 6-41 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site

| | Number of Samples[a] | Minimum Concentration (mg/kg dry weight) | Maximum Concentration (mg/kg dry weight) | Frequency of Detection |
|---|---|---|---|---|
| **Green Alder Bark** | | | | |
| Aluminum | 9 | 3.7 | 24.2 | 8/9 |
| Antimony | 9 | 0.165 J | 3.35 J | 8/9 |
| Arsenic | 9 | 0.06 | 0.91 | 7/9 |
| Barium | 9 | 2.35 | 203 | 8/9 |
| Beryllium | 9 | 0.005 J | 0.015 J | 4/9 |
| Cadmium | 9 | 0.014 J | 0.129 | 6/9 |
| Calcium | 9 | 4560 | 10800 | 8/9 |
| Chromium | 9 | 0.3 J | 1.4 J | 3/9 |
| Cobalt | 9 | 0.064 | 0.528 | 8/9 |
| Copper | 9 | 4.33 | 6.64 | 8/9 |
| Iron | 9 | 17.6 | 34.9 | 8/9 |
| Lead | 9 | 0.06 | 0.113 | 8/9 |
| Magnesium | 9 | 529 | 967 | 8/9 |
| Manganese | 9 | 91.2 | 1140 | 8/9 |
| Mercury | 9 | 0.017 J | 0.289 J | 8/9 |
| Methylmercury | 5 | 0.0037 U | 0.004 U | 0/5 |
| Nickel | 9 | 0.72 | 4.15 | 8/9 |
| Potassium | 9 | 1530 | 2610 | 8/9 |
| Selenium | 9 | 0.22 J | 0.22 J | 1/9 |
| Silver | 9 | 0.016 | 0.193 | 2/9 |
| Sodium | 9 | 9.8 | 17 | 8/9 |
| Thallium | 9 | 0.006 J | 0.03 | 4/9 |
| Vanadium | 9 | 0.03 J | 0.07 | 8/9 |
| Zinc | 9 | 35.9 J | 108 J | 8/9 |
| **Blueberry Leaves and Stems** | | | | |
| Aluminum | 2 | 59.7 | 64.6 | 2/2 |
| Antimony | 2 | 0.096 J | 0.131 J | 2/2 |
| Arsenic | 2 | 0.08 J | 0.15 J | 2/2 |
| Barium | 2 | 50.4 | 68 | 2/2 |
| Beryllium | 2 | 0.003 U | 0.003 J | 1/2 |
| Cadmium | 2 | 0.332 | 1.2 | 2/2 |
| Calcium | 2 | 2400 | 2430 | 2/2 |
| Chromium | 2 | 0.2 U | 0.2 J | 1/2 |
| Cobalt | 2 | 0.035 | 0.099 | 2/2 |
| Copper | 2 | 3.58 | 5.97 | 2/2 |
| Iron | 2 | 20.3 | 25.6 | 2/2 |
| Lead | 2 | 0.061 | 0.067 | 2/2 |
| Magnesium | 2 | 902 | 1120 | 2/2 |
| Manganese | 2 | 1430 | 1630 | 2/2 |
| Mercury | 2 | 0.023 J | 0.034 J | 2/2 |
| Methylmercury | 2 | 0.004 U | 0.004 U | 0/2 |
| Nickel | 2 | 1.89 | 6.68 | 2/2 |
| Potassium | 2 | 3930 | 4340 | 2/2 |
| Selenium | 2 | 0.15 U | 0.15 U | 2/2 |
| Silver | 2 | 0.008 U | 0.008 U | 2/2 |
| Sodium | 2 | 12.2 J | 12.9 J | 2/2 |
| Thallium | 2 | 0.005 J | 0.006 J | 2/2 |
| Vanadium | 2 | 0.03 J | 0.03 J | 2/2 |
| Zinc | 2 | 31.6 J | 42.6 J | 2/2 |
| **Spruce Needles** | | | | |
| Aluminum | 9 | 5.1 | 172 | 8/9 |
| Antimony | 9 | 0.20 J | 15.1 J | 7/9 |
| Arsenic | 9 | 0.11 J | 11.1 | 7/9 |
| Barium | 9 | 4.16 | 85.3 | 7/9 |
| Beryllium | 9 | 0.008 J | 0.008 J | 1/9 |
| Cadmium | 9 | 0.01 J | 0.191 | 7/9 |

**Table 6-41 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site**

| | Number of Samples[a] | Minimum Concentration (mg/kg dry weight) | Maximum Concentration (mg/kg dry weight) | Frequency of Detection |
|---|---|---|---|---|
| Calcium | 9 | 3320 | 9920 | 8/9 |
| Chromium | 9 | 0.4 J | 1.3 J | 5/9 |
| Cobalt | 9 | 0.05 | 0.303 | 8/9 |
| Copper | 9 | 0.93 | 4.42 | 8/9 |
| Iron | 9 | 20.1 | 206 | 8/9 |
| Lead | 9 | 0.009 | 0.466 | 8/9 |
| Magnesium | 9 | 548 | 958 | 8/9 |
| Manganese | 9 | 130 | 2990 | 8/9 |
| Mercury | 9 | 0.03 | 5.64 | 8/9 |
| Methylmercury | 5 | 0.0037 U | 0.004 U | 0/5 |
| Nickel | 9 | 0.67 | 6.35 | 8/9 |
| Potassium | 9 | 3450 | 7740 | 8/9 |
| Selenium | 9 | 0.15 U | 0.15 U | 0/9 |
| Silver | 9 | 0.016 J | 0.114 | 6/9 |
| Sodium | 9 | 4.1 J | 24.8 J | 8/9 |
| Thallium | 9 | 0.005 J | 0.021 J | 2/9 |
| Vanadium | 9 | 0.03 J | 0.47 | 7/9 |
| Zinc | 9 | 13.9 | 53.2 J | 8/9 |
| **Pond Vegetation** | | | | |
| Aluminum | 5 | 8.3 | 94.2 | 4/5 |
| Antimony | 5 | 4.92 J | 97.4 J | 4/5 |
| Arsenic | 5 | 32.1 | 309 | 4/5 |
| Barium | 5 | 18.2 | 36.2 | 4/5 |
| Beryllium | 5 | 0.003 J | 0.006 J | 4/5 |
| Cadmium | 5 | 0.009 J | 0.22 | 4/5 |
| Calcium | 5 | 13300 | 15700 | 4/5 |
| Chromium | 5 | 0.2 J | 0.6 J | 2/5 |
| Cobalt | 5 | 0.308 | 0.886 | 4/5 |
| Copper | 5 | 3.4 | 9.62 | 4/5 |
| Iron | 5 | 124 | 282 | 4/5 |
| Lead | 5 | 0.32 | 1.18 | 4/5 |
| Magnesium | 5 | 6340 | 13400 | 4/5 |
| Manganese | 5 | 46.8 | 199 | 4/5 |
| Mercury | 5 | 0.78 J | 5.28 J | 4/5 |
| Methylmercury | 5 | 0.0069 J | 0.0069 J | 1/1 |
| Nickel | 5 | 1.11 | 3.21 | 4/5 |
| Potassium | 5 | 15400 | 39500 | 4/5 |
| Selenium | 5 | 0.81 | 0.81 | 1/5 |
| Silver | 5 | 0.008 U | 0.008 U | 0/5 |
| Sodium | 5 | 52.5 | 377 | 4/5 |
| Thallium | 5 | 0.017 J | 0.083 | 4/5 |
| Vanadium | 5 | 0.05 J | 0.29 | 4/5 |
| Zinc | 5 | 36 J | 55.7 J | 4/5 |

Key:
-- = Not available or not applicable
J = estimated value
U = undetected (reported value is method detection limit)

Notes:
a = Number of original site samples and field duplicates.
Green alder bark: 8 original site samples and 1 field duplicate.
Blueberry leaves and stems: 2 original site samples and 0 field duplicates.
Blueberry fruit: 0 original site samples and 0 field duplicates.
Spruce needles: 8 original site samples and 1 field duplicate.
Pond vegetation: 4 original site samples and 1 field duplicate.

**Table 6-42 Summary of 2010 Benthic Macroinvertebrate Composite Sample Data for Red Devil Creek, Red Devil Mine Site BERA**

| Analyte | August 2010 Samples[a] | | | | June 2010 Samples[b] | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of Samples | Minimum Detected Concentration (mg/kg wet weight) | Maximum Detected Concentration (mg/kg wet weight) | Frequency of Detection | Number of Samples | Minimum Detected Concentration (mg/kg wet weight) | Maximum Detected Concentration (mg/kg wet weight) | Frequency of Detection |
| Aluminum | -- | -- | -- | -- | 3 | 118.4 | **125** | 3/3 |
| Antimony | -- | -- | -- | -- | 3 | 18.95 | **21.44** | 3/3 |
| Arsenic | -- | -- | -- | -- | 3 | 81.24 | **126.44** | 3/3 |
| Barium | -- | -- | -- | -- | 3 | 4.84 | **6.61** | 3/3 |
| Beryllium | -- | -- | -- | -- | 3 | ND[c] | ND[c] | 0/3 |
| Boron | -- | -- | -- | -- | 3 | 0.67 J+ | **1.011** J+ | 3/3 |
| Cadmium | -- | -- | -- | -- | 3 | 0.082 | **0.166** | 3/3 |
| Calcium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Chromium | -- | -- | -- | -- | 3 | 0.327 | **0.441** | 3/3 |
| Cobalt | -- | -- | -- | -- | 3 | -- | -- | -- |
| Copper | -- | -- | -- | -- | 3 | 6.564 | **12.405** | 3/3 |
| Iron | -- | -- | -- | -- | 3 | 761.3 J- | **974** J- | 3/3 |
| Lead | -- | -- | -- | -- | 3 | 0.131 | **0.154** | 3/3 |
| Magnesium | -- | -- | -- | -- | 3 | 162 | **376** | 3/3 |
| Manganese | -- | -- | -- | -- | 3 | 27.84 | **50.8** | 3/3 |
| Mercury | -- | -- | -- | -- | 3 | 1.60 | **2.38** | 3/3 |
| Methylmercury | 3 | 0.0587 | **0.131** | 3/3 | 3 | 0.0238 | 0.0594 | 3/3 |
| Molybdenum | -- | -- | -- | -- | 3 | 0.1 | **0.19** | 3/3 |
| Nickel | -- | -- | -- | -- | 3 | 0.557 | **1.409** | 3/3 |
| Potassium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Selenium | -- | -- | -- | -- | 3 | 1.002 | **4.046** | 3/3 |
| Silver | -- | -- | -- | -- | 3 | -- | -- | -- |
| Sodium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Strontium | -- | -- | -- | -- | 3 | 1.3 J+ | **2.2** J+ | 3/3 |
| Thallium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Vanadium | -- | -- | -- | -- | 3 | 0.40 | **0.47** | 3/3 |
| Zinc | -- | -- | -- | -- | 3 | 22.6 J- | **44.9** J- | 3/3 |

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK.

Key:
-- (double dash) = not analyzed.
BLM = Bureau of Land Management
**Bold** = maximum detected concentration across both sampling events
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.

Notes:
a = Ephemeroptera, Heptageniidae, *Cinygmula* (mayfly) composite samples with 125 to 176 individuals per sample
b = Ephemeroptera, Baetidae, *Baetis* (mayfly) composite samples with 270 to 425 individuals per sample
c = Beryllium method detection limits = 0.025 mg/kg wet weight.

## Table 6-43 Summary of 2010 Sculpin Data from Red Devil Creek, Red Devil Mine Site BERA

| Analyte | August 2010 Samples | | | | June 2010 Samples | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of Samples | Minimum Detected Concentration (mg/kg wet weight) | Maximum Detected Concentration (mg/kg wet weight) | Frequency of Detection | Number of Samples | Minimum Detected Concentration (mg/kg wet weight) | Maximum Detected Concentration (mg/kg wet weight) | Frequency of Detection |
| Aluminum | 12 | 11.7 | **72.5** | 12/12 | 9 | 3.6 | 20.9 | 9/9 |
| Antimony | 12 | 6.51 | **38.1** | 12/12 | 9 | 0.40 | 4.04 | 9/9 |
| Arsenic | 12 | 6.86 | **24.1** | 12/12 | 9 | 1.10 | 4.49 | 9/9 |
| Barium | 12 | 2.83 | **5.40** | 12/12 | 9 | 2.01 | 4.35 | 9/9 |
| Beryllium | 12 | ND[b] | ND[b] | 0/12 | 9 | ND[b] | ND[b] | 0/9 |
| Boron | 12 | 0.031 | 0.088 | 5/12 | 9 | 0.142 J+ | **0.843** J | 9/9 |
| Cadmium | 12 | 0.029 | 0.056 | 5/12 | 9 | 0.027 | **0.103** | 6/9 |
| Calcium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Chromium | 12 | 0.038 | 0.188 | 12/12 | 9 | 0.028 | **2.431** | 9/9 |
| Cobalt | -- | -- | -- | -- | 9 | -- | -- | -- |
| Copper | 12 | 0.72 | 1.164 | 12/12 | 9 | 0.27 J- | **2.263** J- | 9/9 |
| Iron | 12 | 63.7 | **184** | 12/12 | 9 | 18.9 J- | 61 J- | 9/9 |
| Lead | 12 | 0.027 | **0.079** | 11/12 | 9 | 0.025 J | 0.026 | 2/9 |
| Magnesium | 12 | 280 | 368 | 12/12 | 9 | 251 | **423** | 9/9 |
| Manganese | 12 | 6.65 | **21.3** | 12/12 | 9 | 8.44 | 16.0 | 9/9 |
| Mercury | 12 | 0.68 | **3.70** | 12/12 | 9 | 0.05 | 0.63 | 9/9 |
| Methylmercury | 1 | 0.16 | 0.16 | 1/1 | 1[a] | 0.312 | **0.312** | 1/1 |
| Molybdenum | 12 | 0.028 | **0.038** | 7/12 | 9 | 0.03 | 0.03 | 1/9 |
| Nickel | 12 | 0.083 | **0.263** | 12/12 | 9 | 0.039 | 0.113 | 9/9 |
| Potassium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Selenium | 12 | 1.53 | **2.98** | 12/12 | 9 | 0.834 | 1.43 | 9/9 |
| Silver | -- | -- | -- | -- | 9 | -- | -- | -- |
| Sodium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Strontium | 12 | 10.6 | 30.0 | 12/12 | 9 | 15.5 J+ | **32.8** J+ | 9/9 |
| Thallium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Vanadium | 12 | 0.15 | 0.32 | 12/12 | 9 | 0.10 | **0.40** | 9/9 |
| Zinc | 12 | 20.6 | **35.4** | 12/12 | 9 | 17.1 J- | 30.2 J- | 9/9 |

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK.

Key:
-- (double dash) = not analyzed.
BLM = Bureau of Land Management
**Bold** = maximum detected concentration across both sampling events.
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.

Notes:
a = Composite sample. In June 2010, methylmercury was measured only in a composite sample of three sculpin.
b = Beryllium method dection limits = 0.025 mg/kg wet weight.

**Table 6-44 Exposure Parameters for Wildlife Receptors, Red Devil Mine Site BERA**

| Species | Assumed Diet | Soil or Sediment Ingestion (kg/d) dry | Surface Water Ingestion (L/day) | Home Range (ha) | Site Use Factor [i] | Exposure Duration [j] | Food Ingestion Rate (kg/d) wet | Percent Water in Diet | Food Ingestion Rate (kg/d) dry | Body Weight (kg) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Terrestrial Wildlife** | | | | | | | | | | |
| American Robin[a] | 100% soil invertebrates | 0.00019 | 0.011 | 0.42 | 1.0 | 0.33 | 0.093 | 80% | 0.0186 | 0.077 |
| Masked Shrew[b] | 100% soil invertebrates | 0.00011 | 0.0011 | 0.22 | 1.0 | 1.0 | -- | -- | 0.0021 | 0.0064 |
| Spruce Grouse[c] | 100% conifer foliage | 0.0056 | 0.038 | 3.93 | 1.0 | 1.0 | -- | -- | 0.06 | 0.53 |
| Tundra Vole[b] | 100% herbaceous plants | 0.0002 | 0.0063 | 0.11 | 1.0 | 1.0 | -- | -- | 0.0085 | 0.047 |
| Northern Shrike[d] | 100% small mammals | 0 | 0.0095 | n.a. | 1.0 | 0.33 | -- | -- | 0.0139 | 0.0656 |
| Least Weasel[e] | 100% small mammals | 0 | 0.0053 | n.a. | 1.0 | 1.0 | -- | -- | 0.0048 | 0.039 |
| **Aquatic-Dependent Wildlife** | | | | | | | | | | |
| Common Snipe[b, h] | 100% benthic invertebrates | 0.0016 | 0.014 | 0.1 to 48 | 1.0 | 0.33 | 0.047 | 68% | 0.015 | 0.116 |
| Beaver[f] | 100% alder bark | 0.0037 | 1.76 | n.a. | 1.0 | 1.0 | -- | -- | 0.186 | 24.5 |
| Green Winged Teal[b] | 100% pond vegetation | 0.001 | 0.027 | 243 | 0.004 | 0.33 | -- | -- | 0.053 | 0.32 |
| Belted Kingfisher[g] | 100% forage fish | 0 | 0.016 | 2.2 km | 1.0 | 0.33 | 0.075 | 68% | 0.024 | 0.148 |
| Mink[g] | 100% forage fish | 0 | 0.099 | 1.9 to 2.6 km | 1.0 | 1.0 | 0.137 | 68% | 0.044 | 1 |

Key:
-- = not applicable
BERA = baseline ecological risk assessment
kg = kilogram
kg/d = kilograms per day
L/d = liters per day

Notes:
a. Sample and Suter (1994).
b. Exponent (2007).
c. Exponent (2007) for willow ptarmigan.
d. Dunning (1993) for body weight. Food ingestion rate calculated from body weight using allometric relationship for passerine birds from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
e. EPA (1993) for body weight. Food ingestion rate calculated from body weight using allometric relationship for placental mammals from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
f. Body weight from www.Alaskan-Adventures.com (accessed 6-7-11). Food and water ingestion rates calculated from body weight using allometric relationships from Sample et al. (1996). Soil ingestion rate assumed to be 2% of food ingestion rate.
g. Sample and Suter (1994).
h. Food moisture content of 68% based on EPA (1999) for carnivores. Wet food Ingestion rate = dry food ingestion rate / (1- food moisture content).
i. Site use factor (SUF) of 1 assumed for all receptors except green-winged teal. For the teal, the SUF equals the settling pond surface area (1 ha) divided by the home range (243 ha).
j. Migratory birds (robin, shrike, snipe, teal, kingfisher) assumed to be present at site four months of the year (4/12 = 0.33). Other species assumed to be present year-round.

**Table 6-45 Data Used to Estimate Exposure Point Concentrations for Calculating Exposure Estimates for Wildlife**

| Receptor | Exposure Point Concentration | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Measured Chemical Concentration | | | | | | | | | | Modeled Concentration[a] | |
| | RDC Surface Water | Surface Soil | Sediment | | Spruce Needles[b] | Blueberry Stems and Leaves[b] | Green Alder Bark[b] | Settling Pond Plants[b] | Sculpin[b] | Mayfly[b] | Earthworm | Small Mammal |
| | | | RDC and KR | Settling Ponds | | | | | | | | |
| **Terrestrial Wildlife** | | | | | | | | | | | | |
| American Robin | X | X | | | | | | | | | X | |
| Masked Shrew | X | X | | | | | | | | | X | |
| Spruce Grouse | X | X | | | X | | | | | | | |
| Tundra Vole | X | X | | | | X | | | | | | |
| Northern Shrike | X | | | | | | | | | | | X |
| Least Weasel | X | | | | | | | | | | | X |
| **Aquatic-Dependent Wildlife** | | | | | | | | | | | | |
| Common Snipe | X | | X | | | | | | | X | | |
| Beaver | X | X | | | | | X | | | | | |
| Green Winged Teal | X | | | X | | | | X | | | | |
| Belted Kingfisher | X | | | | | | | | X | | | |
| Mink | X | | | | | | | | X | | | |

Key:
EPC = Exposure Point Concentration
KR = Kuskokwim River
RDC = Red Devil Creek

Notes:
a = Based on surface soil EPC. For chemicals with no available model, the chemical concentration in earthworms and small mammals was set equal to the surface soil EPC.

b = If a chemical was detected in soil or sediment but not analyzed for in biota, the biota chemical concentration was assumed to be equal to the soil or sediment EPC.

**Table 6-46 American Robin and Masked Shrew Exposure Point Concentrations, Red Devil Mine Site BERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Surface Soil EPC (mg/kg)[b] | Soil-to-Earthworm Bioaccumulation Equation[c] | Earthworm EPC (mg/kg) |
|---|---|---|---|---|
| **Metals** | | | | |
| Antimony | 136 | 4234 | $C_e = C_s$ | 4234 |
| Arsenic | 811 | 3596 | $\ln(C_e) = 0.706 * \ln(C_s) – 1.421$ | 78 |
| Barium | 44 | 438.3 | $C_e = 0.091 * C_s$ | 40 |
| Beryllium | 0.009 | 0.734 | $C_e = 0.045 * C_s$ | 0.033 |
| Cadmium | 0.0059 | 0.321 | $\ln(C_e) = 0.795 * \ln(C_s) + 2.114$ | 3.4 |
| Chromium | 0.31 | 29.1 | $C_e = 0.306 * C_s$ | 8.9 |
| Copper | 0.43 | 69.03 | $C_e = 0.5\ 15 * C_s$ | 35.6 |
| Lead | 0.034 | 96.56 | $\ln(C_e) = 0.807 * \ln(C_s) – 0.218$ | 32 |
| Manganese | 171 | 756.6 | $\ln(C_e) = 0.682 * \ln(C_s) – 0.809$ | 41 |
| Mercury | 0.2425 | 251.6 | $\ln(C_e) = 0.118 * \ln(C_s) – 0.684$ | 0.97 |
| Nickel | 10.5 | 52.39 | $C_e = 1.059 * C_s$ | 55 |
| Selenium | 0.39 | 0.42 | $\ln(C_e) = 0.733 * \ln(C_s) – 0.075$ | 0.49 |
| Thallium | 0.0075 | 0.071 | $C_e = C_s$ | 0.071 |
| Vanadium | 0.14 | 34.82 | $C_e = 0.042 * C_s$ | 1.46 |
| Zinc | 0.73 | 110.6 | $\ln(C_e) = 0.328 * \ln(C_s) + 4.449$ | 400 |

Key:
-- = not analyzed
BERA = baseline ecological risk assessment
$C_e$ = chemical concentration in earthworm
$C_s$ = chemical concentration in soil
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
UCL = upper confidence limit
µg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix H).
c. Soil-to-earthworm bioacumulation equations from EPA (2005a), except for nickel, which is from Sample et al. (1998a). For chemicals with no available model, the chemical concentration in earthworms was set equal to the surface soil EPC.

**Table 6-47 Spruce Grouse, Tundra Vole, and Beaver Exposure Point Concentrations, Red Devil Mine Site BERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Surface Soil EPC (mg/kg)[b] | Spruce Needles (mg/kg)[b] | Blueberry Stems and Leaves (mg/kg)[c] | Alder Bark (mg/kg)[b] |
|---|---|---|---|---|---|
| **Metals** | | | | | |
| Antimony | 136 | 4234 | 10.3 | 0.131 | 2.72 |
| Arsenic | 811 | 3596 | 7.6 | 0.15 | 0.53 |
| Barium | 44 | 438 | 59.9 | -- | -- |
| Beryllium | 0.009 | 0.73 | 0.008 | -- | -- |
| Lead | 0.034 | 97 | 0.34 | 0.067 | -- |
| Manganese | 171 | 757 | 1904 | 1630 | -- |
| Mercury | 0.24 | 252 | 5.6 | -- | -- |
| Thallium | 0.0075 | 0.071 | 0.021 | -- | -- |
| Vanadium | 0.14 | 35 | 0.47 | -- | -- |

Key:
-- = not available
BERA = baseline ecological risk assessment
EPC = Exposure Point Concentration
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
SLERA = screening level ecological risk assessment
UCL = upper confidence limit
µg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix H).
c. Maximum detected concentration from Table 6-41.

## Table 6-48 Green-Winged Teal Exposure Point Concentrations, Red Devil Mine Site BERA

| Analyte[a] | Surface Water EPC (ug/L)[b] | Pond "Sediment" EPC (mg/kg)[c] | Settling Pond Vegetation EPC | |
|---|---|---|---|---|
| | | | Value (mg/kg) | Basis |
| **Metals** | | | | |
| Antimony | 136 | 1430 | 97.4 | Maximum measured concentration (Table 6-41 |
| Arsenic | 811 | 9880 | 309 | Maximum measured concentration (Table 6-41 |
| Beryllium | 0.009 | 0.8 | 0.006 | Maximum measured concentration (Table 6-41 |
| Mercury | 0.24 | 127 | 5.28 | Maximum measured concentration (Table 6-41 |
| Thallium | 0.0075 | 0.75 | 0.083 | Maximum measured concentration (Table 6-41 |

Key:
-- = Not analyzed.
BERA = baseline ecological risk assessment
EPC = Exposure point concentration
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
μg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix H).
c. Maximum concentration from three original surface soil samples (10MP32SS, 10MP34SS, and 10MP36SS) and one field duplicate surface soil sample (10MP84SS) collected from the settling ponds.

**Table 6-49 Northern Shrike and Least Weasel Exposure Point Concentrations, Red Devil Mine Site BERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Surface Soil EPC (mg/kg)[b] | Soil- or Diet-to-Small Mammal Bioaccumulation Equation[c] | Small Mammal EPC (mg/kg) |
|---|---|---|---|---|
| **Metals** | | | | |
| Antimony | 136 | 4234 | $C_m = 0.001 * 50 * C_d$ | 0.007 |
| Arsenic | 811 | 3596 | $\ln(C_m) = 0.8188 * \ln(C_s) - 4.8471$ | 6.4 |
| Beryllium | 0.009 | 0.734 | $C_m = 0.001 * 50 * C_d$ | 0.0002 |
| Lead | 0.034 | 96.6 | $\ln(C_m) = 0.4422 * \ln(C_s) + 0.0761$ | 8.1 |
| Thallium | 0.0075 | 0.071 | $C_m = 0.1124 * C_s$ | 0.008 |

Key:
-- = not analyzed
BERA = baseline ecological risk assessment
$C_d$ = chemical concentration in diet (maximum concentration in blueberry stems/leaves)
$C_m$ = chemical concentration in small mammal tissue
$C_s$ = chemical concentration in soil
EPC = Exposure Point Concentration
mg/kg = milligrams per kilogram
NDs = non detects
SLERA = screening level ecological risk assessment
µg/L = micrograms per liter

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix H).
c. EPA (2005a) except for thallium, which is from Sample et al. (1998b).

**Table 6-50 Common Snipe Exposure Point Concentrations, Red Devil Mine Site BERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Sediment EPC (mg/kg)[c] | Benthic Macroinvertebrate EPC (mg/kg) | |
|---|---|---|---|---|
| | | | Value | Basis |
| **Metals** | | | | |
| Antimony | 136 | 4,455 | 21.44 | Maximum measured mayfly concentration (Table 6-42) |
| Arsenic | 811 | 38,302 | 126.4 | Maximum measured mayfly concentration (Table 6-42) |
| Barium | 44 | 681 | 6.61 | Maximum measured mayfly concentration (Table 6-42) |
| Beryllium | 0.009 | 1.32 | 0.013 | One-half method detection limit (Table 6-42) |
| Copper | 0.43 | 37 | 12.4 | Maximum measured mayfly concentration (Table 6-42). |
| Mercury | 0.24 | 67 | 2.38 | Maximum measured mayfly concentration (Table 6-42) |
| Selenium | 0.385 | 0.49 | 4.05 | Maximum measured mayfly concentration (Table 6-42) |
| Thallium | 0.0075 | 0.15 | 0.150 | Not analyzed in benthic invertebrates. See note d. |
| Vanadium | 0.14 | 31 | 0.47 | Maximum measured mayfly concentration (Table 6-42). |

Key:
BERA = baseline ecological risk assessment
EPC = Exposure Point Concentration
HHRA = human health risk assessment
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
µg/L = micrograms per kilogram

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix H).
c. UCL on average concentration for Red Devil Creek and Kuskowkim River near-shore sediment samples (see HHRA EPC tables) except for beryllium, which is from Table 6-38
d. Benthic macroinvertebrate EPC assumed to be equal to sediment EPC.

**Table 6-51 Belted Kingfisher and Mink Exposure Point Concentrations, Red Devil Mine Site BERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Sediment EPC (mg/kg)[c] | Slimy Sculpin EPC | |
|---|---|---|---|---|
| | | | Value (mg/kg) | Basis |
| **Metals** | | | | |
| | 136 | 4,455 | 17.06 | UCL on average concentration (see Appendix H). |
| Arsenic | 811 | 38,302 | 11.4 | UCL on average concentration (see Appendix H). |
| Beryllium | 0.009 | 1.32 | 0.0125 | One-half method detection limit (Table 6-43). |
| Cobalt | 3.04 | 17 | 17 | Not analyzed in sculpin. See note d. |
| Mercury | 0.24 | 67 | 2.14 | UCL on average concentration (see Appendix H). |
| Methylmercury | 0.0003 | 0.0052 | 0.312 | Maximum measured sculpin concentration (Table 6-43). |
| Selenium | 0.39 | 0.49 | 1.9 | UCL on average concentration (see Appendix H). |
| Thallium | 0.0075 | 0.15 | 0.15 | Not analyzed in sculpin. See note d. |

Key:
BERA = baseline ecological risk assessment
EPC = Exposure Point Concentration
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening level ecological risk assessment
µg/L = micrograms per kilogram

Notes:
a. Only metals identified as COPCs in the SLERA are listed.
b. UCL on average concentration or maximum detected concentration (see Appendix H).
c. UCL on average concentration for Red Devil Creek and Kuskowkim River near-shore sediment samples (see HHRA EPC tables) except for beryllium, which is from Table 6-38.
d. Sculpin EPC assumed equal to sediment EPC.

**Table 6-52 Toxicity Reference Values for Birds and Mammals**

| Analyte | Wildlife Class | NOAEL (mg/kg-day) | Critical Effect | LOAEL (mg/kg-day) | Critical Effect | Reference and Comments |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Antimony | Birds | na | na | na | na | na |
| | Mammals | 0.059 | Reproduction | 0.59 | Reproduction | EPA (2005i). Highest bounded NOAEL (0.059 mg/kg-d) for growth or reproduction below lowest bounded LOAEL (0.59 mg/kg-d) for growth or reproduction from 20 laboratory toxicity studies. |
| Arsenic | Birds | 2.24 | Reproduction | 3.55 | Growth | EPA(2005b). Lowest NOAEL for growth, reproduction, or survival from nine laboratory toxicity studies. Lowest LOAEL for growth, reproduction, or survival greater than selected NOAEL. |
| | Mammals | 1.04 | Growth | 1.66 | Growth | EPA (2005b). Highest bounded NOAEL for growth, reproduction, or survival less than lowest bounded LOAEL for growth, reproduction, or survival from 62 laboratory toxicity studies. |
| Barium | Birds | 20.8 | Survival | 41.7 | Survival | Sample et al. (1996). |
| | Mammals | 51.8 | Reproduction, growth, and survival | 121 | Growth and survival | EPA (2005c). Geometric mean NOAEL for growth, reproduction, and survival from 12 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL. |
| Beryllium | Birds | na | na | na | na | na |
| | Mammals | 0.532 | Survival | na | na | EPA (2005d). Lowest NOAEL for growth, reproduction, or survival from four laboratory toxicity studies. |
| Cadmium | Birds | 1.47 | Reproduction, growth, and survival | 2.37 | Reproduction | EPA (2005e). Geometric mean NOAEL for growth, reproduction, and survival from 49 laboratory toxicity studies. Lowest bounded LOAEL for growth, reproduction, or survival greater than geometric mean NOAEL. |
| | Mammals | 0.77 | Growth | 1 | Growth | EPA (2005e). Highest bounded NOAEL (0.77 mg/kg-d) for reproduction, growth, or survival less than the lowest bounded LOAEL (1.0 mg/kg-d) from 141 laboratory toxicity studies. |
| Chromium | Birds | 2.66 | Reproduction, growth, and survival | 2.78 | Survival | EPA (2008). Geometric mean NOAEL for growth, reproduction, and survival from 17 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL. |
| | Mammals | 9.24 | Reproduction and growth | na | na | EPA (2008). Geometric mean NOAEL for reproduction and growth from 10 studies with trivalent chromium. |
| Cobalt | Birds | 7.61 | Growth | 7.8 | Growth | EPA (2005f). Geometric mean NOAEL for growth from 10 toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL. |
| | Mammals | 7.33 | Reproduction and Growth | 10.9 | Reproduction | EPA (2005f). Geometric mean NOAEL for reproduction and growth based on 21 laboratory toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL. |
| Copper | Birds | 4.05 | Reproduction | 4.68 | Growth | EPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (4.05 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (4.68 mg/kg-day). |
| | Mammals | 5.6 | Reproduction | 6.79 | Growth | EPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (5.6 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (6.79 mg/kg-day). |
| Lead | Birds | 1.63 | Reproduction | 1.94 | Reproduction | EPA (2005g). Highest bounded NOAEL (1.63 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (1.94 mg/kg-d) for growth, reproduction, or survival based on 57 laboratory toxicity studies. |
| | Mammals | 4.7 | Growth | 5 | Growth | EPA (2005g). Highest bounded NOAEL (4.7 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (5 mg/kg-d) for growth, reproduction, or survival based on 220 laboratory toxicity studies. |
| Manganese | Birds | 179 | Reproduction and Growth | 348 | Growth | EPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| | Mammals | 51.5 | Reproduction and Growth | 65 | Growth | EPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| Mercury | Birds | 0.45 | Reproduction | 0.9 | Reproduction | Sample et al. (1996). |

**Table 6-52 Toxicity Reference Values for Birds and Mammals**

| Analyte | Wildlife Class | NOAEL (mg/kg-day) | Critical Effect | LOAEL (mg/kg-day) | Critical Effect | Reference and Comments |
|---|---|---|---|---|---|---|
| | Mammals | 13.2 | Reproduction and survival | na | na | Sample et al. (1996). |
| Methylmercury | Birds | 0.068 | Reproduction | 0.37 | Reproduction | CH2MHILL (2000). |
| | Mammals | 0.032 | Reproduction | 0.16 | Reproduction | CH2MHILL (2000). |
| Nickel | Birds | 6.71 | Growth and survival | 11.5 | Growth | EPA (2007c). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| | Mammals | 1.7 | Reproduction | 2.71 | Reproduction | EPA (2007c). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival. |
| Selenium | Birds | 0.291 | Survival | 0.368 | Reproduction | EPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival. |
| | Mammals | 0.143 | Growth | 0.145 | Reproduction | EPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival. |
| Silver | Birds | 2.02 | Growth | 20.2 | Growth | EPA (2006a). Lowest LOAEL for reproduction or growth divided by 10. |
| | Mammals | 6.02 | Growth | 60.2 | Growth | EPA (2006a). Lowest LOAEL for reproduction or growth divided by 10. |
| Thallium | Birds | NA | NA | NA | NA | NA |
| | Mammals | 0.0074 | Reproduction | 0.074 | Reproduction | Sample et al. (1996). |
| Vanadium | Birds | 0.344 | Growth | 0.413 | Reproduction | EPA (2005h). Highest bounded NOAEL (0.344 mg/kg-d) for growth, reproduction, or survival less than lowest bounded LOAEL (0.413 mg/kg-d) for reproduction, growth, or survival based on 94 laboratory toxicity studies. |
| | Mammals | 4.16 | Reproduction and growth | 5.11 | Growth | EPA (2005h). Highest bounded NOAEL (4.16 mg/kg-d) for growth or reproduction less than lowest bounded LOAEL (5.11 mg/kg-d) for growth, reproduction, or survival based on 94 laboratory toxicity studies. |
| Zinc | Birds | 66.1 | Reproduction and Growth | 66.5 | Reproduction | EPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| | Mammals | 75.4 | Reproduction and Growth | 75.9 | Reproduction | EPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |

Key:
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
na = no available
NOAEL = no observed adverse effect level
TRV = toxicity reference value

**Table 6-53 American Robin Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 3.5E+00 | 6.5E-03 | 3.4E+02 | 3.4E+02 | -- | NA | -- | -- |
| Arsenic | 3.0E+00 | 3.9E-02 | 6.3E+00 | 9.3E+00 | 2.24 | 3.55 | 4 | 3 |
| Barium | 3.6E-01 | 2.1E-03 | 3.2E+00 | 3.6E+00 | 20.8 | 41.7 | 0.2 | 0.1 |
| Beryllium | 6.0E-04 | 4.3E-07 | 2.7E-03 | 3.3E-03 | -- | NA | -- | -- |
| Cadmium | 2.6E-04 | 2.8E-07 | 2.7E-01 | 2.7E-01 | 1.47 | 2.37 | 0.2 | 0.1 |
| Chromium | 2.4E-02 | 1.5E-05 | 7.2E-01 | 7.4E-01 | 2.66 | 2.78 | 0.3 | 0.3 |
| Copper | 5.7E-02 | 2.1E-05 | 2.9E+00 | 2.9E+00 | 4.05 | 4.68 | 0.7 | 0.6 |
| Lead | 7.9E-02 | 1.6E-06 | 2.6E+00 | 2.7E+00 | 1.63 | 1.94 | 1.6 | 1.4 |
| Mercury | 2.1E-01 | 1.2E-05 | 7.8E-02 | 2.8E-01 | 0.45 | 0.9 | 0.6 | 0.3 |
| Nickel | 4.3E-02 | 5.0E-04 | 4.5E+00 | 4.5E+00 | 6.71 | 11.5 | 0.7 | 0.4 |
| Thallium | 5.8E-05 | 3.6E-07 | 5.7E-03 | 5.8E-03 | -- | NA | -- | -- |
| Vanadium | 2.9E-02 | 6.5E-06 | 1.2E-01 | 1.5E-01 | 0.344 | 0.413 | 0.4 | 0.4 |
| Zinc | 9.1E-02 | 3.5E-05 | 3.2E+01 | 3.2E+01 | 66.1 | 66.5 | 0.5 | 0.5 |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quoti
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-54 Masked Shrew Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 7.3E+01 | 2.3E-02 | 1.4E+03 | 1.5E+03 | 0.059 | 0.59 | 24781 | 2478 |
| Arsenic | 6.2E+01 | 1.4E-01 | 2.6E+01 | 8.8E+01 | 1.04 | 1.66 | 84 | 53 |
| Barium | 7.5E+00 | 7.5E-03 | 1.3E+01 | 2.1E+01 | 51.8 | 121 | 0.4 | 0.17 |
| Cadmium | 5.5E-03 | 1.0E-06 | 1.1E+00 | 1.1E+00 | 0.77 | 1 | 1.4 | 1.1 |
| Chromium | 5.0E-01 | 5.3E-05 | 2.9E+00 | 3.4E+00 | 9.24 | -- | 0.37 | -- |
| Copper | 1.2E+00 | 7.4E-05 | 1.2E+01 | 1.3E+01 | 5.6 | 6.79 | 2.3 | 1.9 |
| Lead | 1.7E+00 | 5.9E-06 | 1.1E+01 | 1.2E+01 | 4.7 | 5 | 3 | 2 |
| Manganese | 1.3E+01 | 2.9E-02 | 1.3E+01 | 2.6E+01 | 51.5 | 65 | 0.5 | 0.4 |
| Mercury | 4.3E+00 | 4.2E-05 | 3.2E-01 | 4.6E+00 | 13.2 | -- | 0.4 | -- |
| Nickel | 9.0E-01 | 1.8E-03 | 1.8E+01 | 1.9E+01 | 1.7 | 2.71 | 11 | 7 |
| Selenium | 7.2E-03 | 6.6E-05 | 1.6E-01 | 1.7E-01 | 0.143 | 0.145 | 1.2 | 1.2 |
| Thallium | 1.2E-03 | 1.3E-06 | 2.3E-02 | 2.5E-02 | 0.0074 | 0.074 | 3.3 | 0.33 |
| Zinc | 1.9E+00 | 1.2E-04 | 1.3E+02 | 1.3E+02 | 75.4 | 75.9 | 1.8 | 1.8 |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-55 Spruce Grouse Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 4.5E+01 | 9.7E-03 | 1.2E+00 | 4.6E+01 | -- | -- | -- | -- |
| Arsenic | 3.8E+01 | 5.8E-02 | 8.6E-01 | 3.9E+01 | 2.24 | 3.55 | 17 | 11 |
| Barium | 4.6E+00 | 3.1E-03 | 6.8E+00 | 1.1E+01 | 20.8 | 41.7 | 0.5 | 0.27 |
| Beryllium | 7.8E-03 | 6.5E-07 | 9.1E-04 | 8.7E-03 | -- | -- | -- | -- |
| Lead | 1.0E+00 | 2.5E-06 | 3.8E-02 | 1.1E+00 | 1.63 | 1.94 | 0.6 | 0.5 |
| Manganese | 8.0E+00 | 1.2E-02 | 2.2E+02 | 2.2E+02 | 179 | 348 | 1.2 | 0.6 |
| Mercury | 2.7E+00 | 1.7E-05 | 6.4E-01 | 3.3E+00 | 0.45 | 0.9 | 7.3 | 3.7 |
| Thallium | 7.5E-04 | 5.4E-07 | 2.4E-03 | 3.1E-03 | -- | -- | -- | -- |
| Vanadium | 3.7E-01 | 9.8E-06 | 5.3E-02 | 4.2E-01 | 0.344 | 0.413 | 1.2 | 1.0 |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-57 Northern Shrike Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 0.0E+00 | 6.5E-03 | 4.6E-04 | 7.0E-03 | -- | -- | -- | -- |
| Arsenic | 0.0E+00 | 3.9E-02 | 4.5E-01 | 4.9E-01 | 2.24 | 3.55 | 0.22 | 0.14 |
| Beryllium | 0.0E+00 | 4.3E-07 | 1.1E-05 | 1.1E-05 | -- | -- | -- | -- |
| Lead | 0.0E+00 | 1.7E-06 | 5.8E-01 | 5.8E-01 | 1.63 | 1.94 | 0.4 | 0.3 |
| Thallium | 0.0E+00 | 3.6E-07 | 5.6E-04 | 5.6E-04 | -- | -- | -- | -- |

Key:
-- = not available.
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HQ = hazard quotient
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
mg/kg = Milligrams per kilogram
mg/kg/day = Milligrams per kilogram per day
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-58 Least Weasel Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Arsenic | 0.0E+00 | 1.1E-01 | 7.9E-01 | 9.0E-01 | 1.04 | 1.66 | 0.9 | 0.5 |
| Lead | 0.0E+00 | 4.7E-06 | 1.0E+00 | 1.0E+00 | 4.7 | 5 | 0.2 | 0.2 |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-59 Common Snipe Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 2.0E+01 | 5.5E-03 | 2.9E+00 | 2.3E+01 | -- | -- | -- | -- |
| Arsenic | 1.8E+02 | 3.3E-02 | 1.7E+01 | 1.9E+02 | 2.24 | 3.55 | 86 | 54 |
| Barium | 3.1E+00 | 1.8E-03 | 8.9E-01 | 4.0E+00 | 20.8 | 41.7 | 0.2 | 0.10 |
| Beryllium | 6.1E-03 | 3.6E-07 | 1.7E-03 | 7.8E-03 | -- | NA | -- | -- |
| Copper | 1.7E-01 | 1.7E-05 | 1.7E+00 | 1.8E+00 | 4.05 | 4.68 | 0.5 | 0.4 |
| Mercury | 3.1E-01 | 9.8E-06 | 3.2E-01 | 6.3E-01 | 0.45 | 0.9 | 1.4 | 0.7 |
| Selenium | 2.3E-03 | 1.5E-05 | 5.4E-01 | 5.5E-01 | 0.291 | 0.368 | 1.9 | 1.5 |
| Thallium | 6.9E-04 | 3.0E-07 | 2.0E-02 | 2.1E-02 | -- | -- | -- | -- |
| Vanadium | 1.4E-01 | 5.5E-06 | 6.3E-02 | 2.1E-01 | 0.344 | 0.413 | 0.60 | 0.50 |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
**a.** Only metals identified as COPCs in the SLERA are listed.

Table 6-60 Beaver Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 6.4E-01 | 9.7E-03 | 2.1E-02 | 6.7E-01 | 0.059 | 0.59 | 11 | 1.1 |
| Arsenic | 5.4E-01 | 5.8E-02 | 4.0E-03 | 6.1E-01 | 1.04 | 1.66 | 0.6 | 0.4 |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

## Table 6-61 Green Winged Teal Estimates and Hazard Quotients, Red Devil Mine Site BERA

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 6.1E-03 | 1.6E-05 | 2.2E-02 | 2.8E-02 | -- | -- | -- | -- |
| Arsenic | 4.2E-02 | 9.4E-05 | 7.0E-02 | 1.1E-01 | 2.24 | 3.55 | 0.05 | 0.03 |
| Beryllium | 3.4E-06 | 1.0E-09 | 1.4E-06 | 4.8E-06 | -- | -- | -- | -- |
| Mercury | 5.4E-04 | 2.8E-08 | 1.2E-03 | 1.7E-03 | 0.45 | 0.9 | 0.004 | 0.002 |
| Thallium | 3.2E-06 | 8.7E-10 | 1.9E-05 | 2.2E-05 | -- | -- | -- | -- |

Key:
-- = Not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated exposure from incidental sediment (i.e., dry surface soil) ingestion
EE-total = total chemical exposure
HQ = hazard quotient
NOAEL = no observed adverse effect level
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-62 Belted Kingfisher Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 0.00 | 4.9E-03 | 2.88 | 2.89 | -- | -- | -- | -- |
| Arsenic | 0.00 | 2.9E-02 | 1.93 | 1.95 | 2.24 | 3.55 | 0.9 | 0.6 |
| Beryllium | 0.00 | 3.2E-07 | 0.00 | 0.00 | -- | -- | -- | -- |
| Cobalt | 0.00 | 1.1E-04 | 2.87 | 2.87 | 7.61 | 7.8 | 0.38 | 0.37 |
| Mercury | 0.00 | 8.7E-06 | 0.36 | 0.36 | 0.45 | 0.9 | 0.8 | 0.4 |
| Methylmercury | 0.00 | 1.1E-08 | 0.05 | 0.05 | 0.068 | 0.37 | 0.8 | 0.14 |
| Selenium | 0.00 | 1.4E-05 | 0.32 | 0.32 | 0.291 | 0.368 | 1.1 | 0.9 |
| Thallium | 0.00 | 2.7E-07 | 0.03 | 0.03 | -- | -- | -- | -- |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-63 Mink Exposure Estimates and Hazard Quotients, Red Devil Mine Site BERA**

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | LOAEL (mg/kg/d) | HQ-NOAEL | HQ-LOAEL |
|---|---|---|---|---|---|---|---|---|
| **Metals** | | | | | | | | |
| Antimony | 0.00 | 1.3E-02 | 2.34 | 2.35 | 0.059 | 0.59 | 40 | 4.0 |
| Arsenic | 0.00 | 8.0E-02 | 1.56 | 1.64 | 1.04 | 1.66 | 1.6 | 1.0 |
| Methylmercury | 0.00 | 3.1E-08 | 0.043 | 0.043 | 0.032 | 0.16 | 1.3 | 0.27 |
| Selenium | 0.00 | 3.8E-05 | 0.26 | 0.26 | 0.143 | 0.145 | 1.8 | 1.8 |
| Thallium | 0.00 | 7.5E-07 | 0.007 | 0.007 | 0.0074 | 0.74 | 0.9 | 0.01 |

Key:
-- = not available
BERA = baseline ecological risk assessment
COPC = chemical of potential concern
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
HQ = hazard quotient

mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Only metals identified as COPCs in the SLERA are listed.

**Table 6-64  Percent of Total Concentration in Surface Soil Solubilized Via SPLP Extraction for Antimony, Arsenic, and Mercury.**

| Sample ID | Antimony | | | | | Arsenic | | | | | Mercury | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total Antimony (mg/kg) | | SPLP Antimony (µg/L) | | Percent of Total Antimony Solubilized via SPLP | Total Arsenic (mg/kg) | | SPLP Arsenic (µg/L) | | Percent of Total Arsenic Solubilized via SPLP | Total Mercury (mg/kg) | | SPLP Mercury (µg/L) | | Percent of Total Mercury Solubilized via SPLP |
| 10DS01SS | 40 | J | 60 | | 3.0% | 1010 | | 50 | U | -- | 71 | | 1.6 | J | 0.0% |
| 10MP01SS | 20 | J | 70 | | 7.0% | 100 | | 50 | U | -- | 2.6 | | 0.1 | | 0.1% |
| 10MP02SS | 210 | J | 90 | | 0.9% | 7310 | | 440 | | 0.1% | 88 | | 0.6 | | 0.0% |
| 10MP030405SS | 5500 | J | 9250 | | 3.4% | 5580 | | 3050 | | 1.1% | 680 | | 30 | | 0.1% |
| 10MP06070809SS | 4420 | J | 8190 | | 3.7% | 4520 | | 2810 | | 1.2% | 750 | | 8 | | 0.0% |
| 10MP16SS | 1570 | J | 2790 | | 3.6% | 6950 | | 3870 | | 1.1% | 290 | | 5.7 | | 0.0% |
| 10MP17SS | 6180 | J | 7740 | | 2.5% | 5540 | | 4900 | | 1.8% | 460 | | 14.7 | | 0.1% |
| 10MP25SS | 14100 | | 9240 | | 1.3% | 5400 | | 3820 | | 1.4% | 1340 | | 21 | J | 0.0% |
| 10MP26SS | 15100 | | 11200 | | 1.5% | 6420 | | 4890 | | 1.5% | 1620 | | 12 | J | 0.0% |
| 10MP27SS | 8480 | | 10700 | | 2.5% | 6100 | | 3660 | | 1.2% | 250 | | 1.5 | J | 0.0% |
| 10MP29SS | 16700 | | 31300 | | 3.7% | 6170 | | 6000 | | 1.9% | 440 | | 7 | J | 0.0% |
| 10MP32SS | 1430 | | 3660 | | 5.1% | 9880 | | 2310 | | 0.5% | 127 | | 3.3 | J | 0.1% |
| 10MP34SS | 780 | | 480 | | 1.2% | 8510 | | 700 | J | 0.2% | 79 | | 1.2 | J | 0.0% |
| 10MP36SS | 690 | | 510 | | 1.5% | 7050 | | 570 | J | 0.2% | 75 | | 1.4 | J | 0.0% |
| 10MP41SS | 39 | | 50 | U | -- | 516 | | 50 | U | -- | 8 | | 0.9 | J | 0.2% |
| 10MP424344SS | 880 | | 1580 | | 3.6% | 1840 | | 590 | J | 0.6% | 136 | | 3.9 | J | 0.1% |
| 10MP5051525354SS | 10100 | J | 9140 | | 1.8% | 3610 | | 2000 | | 1.1% | 144 | | 174 | | 2.4% |
| 10MP55565758SS | 764 | J | 960 | | 2.5% | 1100 | | 920 | | 1.7% | 114 | | 15 | | 0.3% |
| 10MP59SS | 170 | J | 110 | | 1.3% | 1130 | | 370 | | 0.7% | 115 | | 0.2 | | 0.0% |
| 10OP01SS | 3520 | J | 1950 | | 1.1% | 5340 | | 4430 | | 1.7% | 170 | | 4.8 | J | 0.1% |
| 10RD04SS | 381 | J | 620 | | 3.3% | 1210 | | 540 | | 0.9% | 99 | | 37 | | 0.7% |
| 10RD06SS | 677 | J | 1290 | | 3.8% | 1250 | | 660 | | 1.1% | 186 | | 40 | | 0.4% |
| 10RD09SS | 1.4 | UJ | 50 | U | -- | 20 | | 50 | J | 5.0% | 2 | | 0.1 | UJ | -- |
| 10RD11SS | 14 | J | 50 | U | -- | 41 | | 50 | UJ | -- | 6.6 | | 0.7 | J | 0.2% |
| 10RD12SS | 0.69 | UJ | 50 | U | -- | 25 | | 50 | U | -- | 0.79 | | 0.1 | U | -- |
| 10RD18SS | 0.8 | UJ | 50 | U | -- | 40 | | 50 | U | -- | 1.57 | | 0.1 | U | -- |
| 10RD19SS | 0.76 | UJ | 50 | U | -- | 12 | | 50 | U | -- | 1.86 | | 0.1 | U | -- |
| 10RS01SS | 34 | J | 50 | U | -- | 29 | | 50 | U | -- | 1.25 | | 0.1 | U | -- |
| 10SM03SS | 90 | J | 50 | U | -- | 2290 | | 170 | | 0.1% | 21 | | 1.3 | | 0.1% |
| 10SM05SS | 140 | J | 50 | U | -- | 5120 | | 560 | | 0.2% | 102 | | 1.6 | | 0.0% |
| 10SM07SS | 2.3 | UJ | 50 | U | -- | 8510 | | 300 | | 0.1% | 174 | | 4.2 | | 0.0% |
| 10SM12SS | 1.2 | UJ | 50 | U | -- | 90 | | 50 | U | -- | 5.4 | J | 0.1 | U | -- |
| 10SM13SS | 40 | J | 110 | | 5.5% | 670 | | 50 | U | -- | 23 | J | 1.3 | J | 0.1% |
| 10SM18SS | 1.2 | UJ | 50 | U | -- | 230 | | 50 | U | -- | 11 | J | 0.3 | J | 0.1% |
| 10SM19SS | 20 | J | 50 | U | -- | 670 | | 70 | | 0.2% | 14 | J | 2 | J | 0.3% |
| 10SM21SS | 0.47 | UJ | 50 | U | -- | 39 | | 50 | U | -- | 2 | J | 0.1 | U | -- |
| 10SM23SS | 508 | J | 1430 | | 5.6% | 223 | | 90 | | 0.8% | 8.2 | J | 1 | J | 0.2% |
| 10SM27SS | 1.2 | UJ | 50 | U | -- | 20 | | 50 | U | -- | 1.9 | J | 0.2 | J | 0.2% |
| 10SM28SS | 109 | J | 380 | | 7.0% | 177 | | 50 | U | -- | 17 | J | 1.4 | J | 0.2% |
| 10UP09SS | 0.56 | UJ | 50 | U | -- | 23 | | 50 | U | -- | 0.25 | | 0.1 | U | -- |
| 10UP10SS | 0.59 | UJ | 50 | U | -- | 16 | | 50 | U | -- | 0.22 | | 0.1 | U | -- |

Key:

J = Estimated value

mg/kg = milligrams per kilogram

SPLP = synthetic precipitation leaching procedure

U = Not detected; listed value is method detection limit.

µg/L = micrograms per liter

-- = Calculation not performed on nondetect results

## Table 6-65 Summary of COCs by Assessment Endpoint, Red Devil Mine Site BERA

| Analyte[b] | Assessment Endpoint and HQ[a] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Terrestrial Wildlife[h] | | | | | | Aquatic-Dependent Wildlife[i] | | | | |
| | Plants[c] | Soil Fauna[d] | Fish and Other Aquatic Biota[e] | Fish[f] | Benthos[g] | Robin | Shrew | Grouse | Vole | Shrike | Weasel | Snipe | Beaver | Teal | Kingfisher | Mink |
| **Metals** | | | | | | | | | | | | | | | | |
| Antimony | x | 54 | 4.5 | x | 990 | x | **2,478** | x | **31** | x | | x | **1.1** | x | x | **4.0** |
| Arsenic | 198 | x | 5.4 | 6.7 | 696 | **3** | **53** | **11** | **9.3** | | | **54** | | | | **1.0** |
| Barium | x | 1.3 | 11 | x | x | | | | | | | | | | | |
| Beryllium | x | | | | x | x | | x | | x | | x | | x | x | |
| Cadmium | | | | | | | **1.1** | | | | | | | | | |
| Chromium | | x | | | | | | | | | | | | | | |
| Cobalt | 1.4 | x | | | | | | | | | | | | | | |
| Copper | | | | | | | **1.9** | | | | | | | | | |
| Iron | | | 1.3 | | 2.4 | | | | | | | | | | | |
| Lead | | | | | | **1.6** | **2** | | | | | | | | | |
| Manganese | 3.4 | 1.7 | 1.4 | x | 2.7 | | | | **4.6** | | | | | | | |
| Mercury | 839 | 2,516 | 20 | 4.7 | 34 | | | **3.7** | | | | | | | | |
| Methylmercury | | | | 1.0 | x | | | | | | | | | | | |
| Nickel | 1.4 | | | | 1.3 | | **7** | | | | | | | | | |
| Selenium | | | | 1.7 | | | **1.2** | | | | | **1.5** | | | | **1.8** |
| Silver | | x | | | | | | | | | | | | | | |
| Thallium | | x | | | x | x | | x | | x | | x | | x | x | |
| Vanadium | 17.4 | x | | x | x | | | **1** | | | | | | | | |
| Zinc | | | | | | | **1.8** | | | | | | | | | |

Key:
BERA = Baseline Ecological Risk Assessment
COC = contaminant of concern
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
SLERA = screening level ecological risk assessment
TRV = toxicity reference value
Value (with or without shading) = HQ equal to or greater than 1.
x = chemical detected in site samples but no screening level or TRV is available.

Notes:
a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):

Value (black shading) = > 75%
Vaue (dark grey shading) = 50 - 75%
Value (light grey shading) = 25 - 50%
Value (no shading) = < 25%

For wildlife, the value of the HQ (exposure estimate / LOAEL) is shown without shading because wildlife HQs were not calculated sample-by-sample.
b. Only metals identified as COPCs in the SLERA for at least one assessment endpoint are listed.
c. Based on comparing soil chemical concentrations with soil screening levels for effects on plants (see Table 6.3-3).
d. Based on comparing soil chemical concentrations with soil screening levels for effects on earthworms (see Table 6.3-3).
e. Based on comparing surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see Table 6.3-4).
f. Based on comparing whole-body sculpin chemical concentrations with fish tissue screening concentrations (see Table 6.3-6).
g. Based on comparing sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see Table 6.3-5).
h. Based on exposure estimates and hazard quotients for the American robin (Table 6.3-19), masked shrew (Table 6.3-20), spruce grouse (Table 6.3-21), tundra vole (Table 6.3-22), northern shrike (Table 6.3-23), and least weasel (Table 6.3-24).
i. Based on exposure estimates and HQs for the common snipe (Table 6.3-25), beaver (Table 6.3-26), green-winged teal (Table 6.3-27), belted kingfisher (Table 6.3-28), and mink (Table 6.3-29).

### Table 6-66 Human Health Compounds of Concern

| Medium | Future Resident | Recreational/ Subsistence User | Mine Worker |
|---|---|---|---|
| Soil | Arsenic<br>Antimony<br>Mercury | Arsenic<br>Antimony<br>Mercury | Arsenic<br>Antimony<br>Mercury |
| Sediment | Arsenic | Arsenic | Arsenic |
| Groundwater | Arsenic<br>Antimony<br>Cobalt (MPA and DA only)<br>Manganese<br>Mercury (MPA and DA only) | | Arsenic<br>Antimony<br>Manganese |
| Surface Water | | Arsenic | |

Key:
DA Downstream Alluvial Area
MPA Main Processing Area

### Table 6-67 Risk-Based Cleanup Levels for COCs

| Medium | Future Resident | Recreational/Subsistence User | Mine Worker |
|---|---|---|---|
| Soil | Arsenic – 8 mg/kg<br>Antimony – 40 mg/kg<br>Mercury – 30 mg/kg | Arsenic – 24 mg/kg<br>Antimony – 120 mg/kg<br>Mercury – 4 mg/kg | Arsenic – 22 mg/kg<br>Antimony – 410 mg/kg<br>Mercury – 32 mg/kg |
| Sediment | Arsenic – 175 mg/kg | Arsenic – 175 mg/kg | Arsenic – 268 mg/kg |
| Groundwater | Arsenic – 0.45 µg/L<br>Antimony – 6 µg/L<br>Cobalt – 5 µg/L<br>Manganese – 375 µg/L<br>Mercury – 5 µg/L | | Arsenic – 0.79 µg/L<br>Antimony – 20 µg/L<br>Manganese – 1180 µg/L |
| Surface Water | | Arsenic – 8 µg/L | |

Key:
µg/L micrograms per liter
mg/kg milligrams per kilogram

**Table 6-68 Preliminary Ecological Risk Based Cleanup Levels for Arsenic**

| Assessment Endpoint | Medium | Proposed Cleanup Level Value | Method of Derivation | Confidence |
|---|---|---|---|---|
| Terrestrial Plants | Surface Soil | None proposed. Methods are available that could be used to develop a site-specific no-effect level for arsenic in soil, but this was not undertaken for the BERA. | Not applicable. | Not applicable. |
| Soil Invertebrates | Surface Soil | None proposed. Methods are available that could be used to develop a site-specific no-effect level for arsenic in soil, but this was not undertaken for the BERA. | Not applicable. | Not applicable. |
| Aquatic Biota (excluding fish) Exposed to Surface Water | Surface Water | None required. No impacts to the benthic macroinvertebrate community in Red Devil Creek (RDC) are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of arsenic in surface water from RDC are not adversely affecting aquatic life. | Not applicable. | Not applicable. |
| Fish Community | Sediment and Surface Water | None proposed. Relationship between arsenic levels in sediment, surface water, and fish is not well understood at the site. | Not applicable. | Not applicable. |
| Benthic Macroinvertebrates | Sediment | None required. No impacts to the benthic macroinvertebrate community in RDC are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of arsenic in sediment from RDC are not adversely affecting benthic life. | Not applicable. | Not applicable. |
| Invertivorous bird (American robin) | Surface Soil | **590 mg/kg** (NOAEL) and **1065 mg/kg** (LOAEL) | Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated with exposure equations and parameters from Section 6.3.6.7. | Low. Arsenic levels in the assumed prey of the robin (earthworms) were calculated with a soil-to-earthworm bioaccumulation model from the literature that has not been verified for use at the site. Also, it is not know if earthworms are a component of the soil invertebrate community at the site given the location and regional climate. |
| Invertivorous mammal (masked shrew) | Surface Soil | **18 mg/kg** (NOAEL) and **35 mg/kg** (LOAEL) | Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated with exposure equations and parameters from Section 6.3.6.7. | Low. Arsenic levels in the assumed prey of the shrew (earthworms) were calculated with a soil-to-earthworm bioaccumulation model from the literature that has not been verified for use at the site. Also, it is not know if earthworms are a component of the soil invertebrate community at the site given the location and regional climate. |
| Herbivorous bird (spruce grouse) | Surface Soil | **208 mg/kg** (NOAEL) and **330 mg/kg** (LOAEL) | Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. | Low. Assumes 100% bioavailability of arsenic in soil incidentally ingested by herbivorous birds. True bioavailability may be less (see Section 6.3.7). |

**Table 6-68 Preliminary Ecological Risk Based Cleanup Levels for Arsenic**

| Assessment Endpoint | Medium | Proposed Cleanup Level Value | Method of Derivation | Confidence |
|---|---|---|---|---|
| Herbivorous mammal (tundra vole) | Surface Soil | **245 mg/kg** (NOAEL) and **390 mg/kg** (LOAEL) | Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. | Low. Assumes 100% bioavailability of arsenic in soil incidentally ingested by herbivorous mammals. True bioavailability may be less (see Section 6.3.7). |
| Carnivorous bird (northern shrike) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Carnivorous mammal (least weasel) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Semi-aquatic invertivorous bird (common snipe) | Sediment | **445 mg/kg** (NOAEL) and **705 mg/kg** (LOAEL) | Sediment concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. | Low. Assumes 100% bioavailability of arsenic in sediment incidentally ingested by birds feeding on creek benthic organisms. True bioavailability may be less. |
| Semi-aquatic herbivorous mammal (beaver) | Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Semi-aquatic herbivorous bird (green-winged teal) | Pond Sediment | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Piscivorous bird (belted kingfisher) | Sediment | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Piscivorous mammal (mink) | Sediment | **22,980 mg/kg** (NOAEL) and **38,302 mg/kg** (LOAEL) | Sediment concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. Arsenic levels in fish from RDC assumed to decrease proportionally with sediment arsenic levels. | Low. Relationship between arsenic levels in site sediment and fish is not well understood. |

Key:
BERA = baseline ecological risk assessment
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NOAEL = no observed adverse effect level
RDC = Red Devil Creek
TRV = toxicity reference values

**Table 6-69 Preliminary Ecological Risk Based Cleanup Levels for Antimony.**

| Assessment Endpoint | Medium | Proposed Cleanup Level Value | Method of Derivation | Confidence |
|---|---|---|---|---|
| Terrestrial Plants | Surface Soil | None proposed. Methods are available that could be used to develop a site-specific no-effect level for antimony in soil, but this was not undertaken for the BERA. | Not applicable. | Not applicable. |
| Soil Invertebrates | Surface Soil | None proposed. Methods are available that could be used to develop a site-specific no-effect level for antimony in soil, but this was not undertaken for the BERA. | Not applicable. | Not applicable. |
| Aquatic Biota (excluding fish) Exposed to Surface Water | Surface Water | None required. No adverse impacts to the benthic macroinvertebrate community in Red Devil Creek (RDC) are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of antimony in surface water from RDC are not adversely affecting aquatic life. | Not applicable. | Not applicable. |
| Fish Community | Sediment and Surface Water | None proposed. Relationship between antimony levels in sediment, surface water, and fish is not well understood at the site. | Not applicable. | Not applicable. |
| Benthic Macroinvertebrates | Sediment | None required. No impacts to the benthic macroinvertebrate community in RDC are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of antimony in sediment from RDC are not adversely affecting benthic life. | Not applicable. | Not applicable. |
| Invertivorous bird (American robin) | Surface Soil | None proposed. An avian toxicity reference value (TRV) for antimony is not available; hence, a risk-based soil cleanup level for protection of invertivorous birds cannot be calculated. | Not applicable. | Not applicable. |
| Invertivorous mammal (masked shrew) | Surface Soil | None proposed. A soil-to-earthworm bioaccumulation model is not available for antimony; hence, a risk-based soil cleanup level for protection of invertivorous mammals cannot be calculated. | Not applicable. | Not applicable. |
| Herbivorous bird (spruce grouse) | Surface Soil | None proposed. An avian TRV for antimony is not available; hence, a credible risk-based soil cleanup level for protection of herbivorous birds cannot be calculated. | Not applicable. | Not applicable. |
| Herbivorous mammal (tundra vole) | Surface Soil | **14 mg/kg** (NOAEL) and **139 mg/kg** (LOAEL) | Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. | Low. Assumes 100% bioavailability of antimony in soil incidentally ingested by herbivorous mammals. True bioavailability may be less (see Section 6.3.7). |
| Carnivorous bird (northern shrike) | Surface Soil | None proposed. An avian TRV for antimony is not available; hence, a risk-based soil cleanup level for protection of carnivorous birds cannot be calculated. | Not applicable. | Not applicable. |
| Carnivorous mammal (least weasel) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |

**Table 6-69 Preliminary Ecological Risk Based Cleanup Levels for Antimony.**

| Assessment Endpoint | Medium | Proposed Cleanup Level Value | Method of Derivation | Confidence |
|---|---|---|---|---|
| Semi-aquatic invertivorous bird (common snipe) | Sediment | None proposed. An avian TRV for antimony is not available; hence, a risk-based sediment cleanup level for protection of invertivorous birds cannot be calculated. | Not applicable. | Not applicable. |
| Semi-aquatic herbivorous mammal (beaver) | Soil | **380 mg/kg** (NOAEL) and **3800 mg/kg** (LOAEL) | Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. | Low. Assumes 100% bioavailability of antimony in soil incidentally ingested by herbivorous mammals. True bioavailability may be less (see Section 6.3.7). |
| Semi-aquatic herbivorous bird (green-winged teal) | Pond Sediment | None proposed. An avian TRV for antimony is not available; hence, a risk-based sediment cleanup level for protection of herbivorous waterfowl cannot be calculated. | Not applicable. | Not applicable. |
| Piscivorous bird (belted kingfisher) | Sediment | None proposed. An avian TRV for antimony is not available; hence, a risk-based sediment cleanup level for protection of piscivorous birds cannot be calculated. | Not applicable. | Not applicable. |
| Piscivorous mammal (mink) | Sediment | **113 mg/kg** (NOAEL) and **1128 mg/kg** (LOAEL) | Sediment concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. Antimony levels in fish from RDC assumed to decrease proportionally with sediment antimony levels. | Low. Relationship between antimony levels in site sediment and fish not well understood. |

Key:
BERA = baseline ecological risk assessment
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NOAEL = no observed adverse effect level
RDC = Red Devil Creek
TRV = toxicity reference values

**Table 6-70 Preliminary Ecological Risk Based Cleanup Levels for Mercury.**

| Assessment Endpoint | Medium | Proposed Cleanup Level Value | Method of Derivation | Confidence |
|---|---|---|---|---|
| Terrestrial Plants | Surface Soil | None proposed. Methods are available that could be used to develop a site-specific no-effect level for mercury in soil, but this was not undertaken for the BERA. | Not applicable. | Not applicable. |
| Soil Invertebrates | Surface Soil | None proposed. Methods are available that could be used to develop a site-specific no-effect level for mercury in soil, but this was not undertaken for the BERA. | Not applicable. | Not applicable. |
| Aquatic Biota (excluding fish) Exposed to Surface Water | Surface Water | None required. No adverse impacts to the benthic macroinvertebrate community in Red Devil Creek (RDC) are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of mercury in surface water from RDC are not adversely affecting aquatic life. | Not applicable. | Not applicable. |
| Fish Community | Sediment and Surface Water | None proposed. Relationship between mercury levels in sediment, surface water, and fish is not well understood at that site. | Not applicable. | Not applicable. |
| Benthic Macroinvertebrates | Sediment | None required. No impacts to the benthic macroinvertebrate community in RDC are evident compared with nearby reference creeks (see Section 6.3.6.4), suggesting that current levels of mercury in sediment from RDC are not adversely affecting benthic life. | Not applicable. | Not applicable. |
| Invertivorous bird (American robin) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Invertivorous mammal (masked shrew) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Herbivorous bird (spruce grouse) | Surface Soil | **34.5 mg/kg** (NOAEL) and **69 mg/kg** (LOAEL) | Soil concentrations resulting in HQ-NOAEL and HQ-LOAEL of 1. Back-calculated using exposure equations and parameters from Section 6.3.6.7. | Low. Assumes 100% bioavailability of mercury in soil incidentally ingested by herbivorous mammals. True bioavailability likely is less (see Sections 6.3.7 and 5.2.2). |
| Herbivorous mammal (tundra vole) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Carnivorous bird (northern shrike) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Carnivorous mammal (least weasel) | Surface Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Semi-aquatic invertivorous bird (common snipe) | Sediment | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Semi-aquatic herbivorous mammal (beaver) | Soil | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Semi-aquatic herbivorous bird (green-winged teal) | Pond Sediment | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Piscivorous bird (belted kingfisher) | Sediment | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |
| Piscivorous mammal (mink) | Sediment | None required. HQ-NOAEL < 1 for this receptor. | Not applicable. | Not applicable. |

Key:

BERA = baseline ecological risk assessment
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
NOAEL = no observed adverse effect level
RDC = Red Devil Creek
TRV = toxicity reference values

# D

# Human Health Risk Assessment Risk Hazard Tables

## Table D-1
## CALCULATION OF CANCER RISKS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - SMA
Receptor Age: Combined Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 5.66E+03 | mg/kg | 5.66E+03 | mg/kg | 5.66E+03 | 4.10E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **6.15E-03** |
| Soil | Dermal | Arsenic (inorganic) | 5.66E+03 | mg/kg | 5.66E+03 | mg/kg | 5.66E+03 | 6.47E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **9.71E-04** |
| Sediment | Dermal | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.29E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.43E-03** |
| Groundwater | Ingestion | Arsenic (Inorganic) | 3.91E+01 | ug/L | 3.91E+01 | ug/L | 3.91E+01 | 5.82E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **8.72E-04** |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Groundwater | Dermal | Arsenic (Inorganic) | 3.91E+01 | ug/L | 3.91E-02 | mg/L | 3.91E-02 | 1.29E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 1.94E-06 |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Surface Water | Dermal | Arsenic | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 4.85E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 7.27E-06 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 5.66E+03 | mg/kg | 8.32E-03 | ug/m3 | 8.32E-03 | 1.58E-03 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 6.81E-06 |
| | | | | | | | | | | | **Cancer Risk** | **1.14E-02** |

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Unites | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 2.36E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.54E-03** |
| Large Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 1.66E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.50E-05** |
| Small Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 1.50E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.26E-04** |
| Birds | Ingestion | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 6.29E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **9.44E-04** |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 5.66E+03 | mg/kg | 3.40E+01 | mg/kg | 3.40E+01 | 3.71E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **5.56E-03** |
| | | | | | | | | | | | **Cancer Risk** | **1.03E-02** |

| | |
|---|---|
| **Total Excess Cancer Risk** | **2.17E-02** |

## Table D-2
## CALCULATION OF CANCER RISKS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - MPA
Receptor Age: Combined Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 7.80E+03 | mg/kg | 7.80E+03 | mg/kg | 7.80E+03 | 5.66E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **8.48E-03** |
| Soil | Dermal | Arsenic (inorganic) | 7.80E+03 | mg/kg | 7.80E+03 | mg/kg | 7.80E+03 | 8.93E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **1.34E-03** |
| Sediment | Dermal | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.29E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.43E-03** |
| Groundwater | Ingestion | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+03 | ug/L | 1.80E+03 | 2.68E-02 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **4.02E-02** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 8.48E-05 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 1.19E-06 |
| Groundwater | Dermal | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+00 | mg/L | 1.80E+00 | 5.96E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **8.94E-05** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Surface Water | Dermal | Arsenic | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 4.85E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 7.27E-06 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 7.80E+03 | mg/kg | 1.15E-02 | ug/m3 | 1.15E-02 | 2.18E-03 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 9.39E-06 |
| | | | | | | | | | | | **Cancer Risk** | **5.36E-02** |

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 2.36E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.54E-03** |
| Large Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 1.66E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.50E-05** |
| Small Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 1.50E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.26E-04** |
| Birds | Ingestion | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 6.29E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **9.44E-04** |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 7.80E+03 | mg/kg | 4.68E+01 | mg/kg | 4.68E+01 | 5.12E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **7.67E-03** |
| | | | | | | | | | | | **Cancer Risk** | **1.24E-02** |

| | | | |
|---|---|---|---|
| **Total Excess Cancer Risk** | | **Total Excess Cancer Risk** | **6.60E-02** |

# Table D-3
# CALCULATION OF CANCER RISKS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - DA
Receptor Age: Combined Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 3.41E+03 | mg/kg | 3.41E+03 | mg/kg | 3.41E+03 | 2.47E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.70E-03** |
| Soil | Dermal | Arsenic (inorganic) | 3.41E+03 | mg/kg | 3.41E+03 | mg/kg | 3.41E+03 | 3.89E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **5.84E-04** |
| Sediment | Dermal | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.29E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.43E-03** |
| Groundwater | Ingestion | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+03 | ug/L | 1.80E+03 | 2.68E-02 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **4.02E-02** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 8.48E-05 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 1.19E-06 |
| Groundwater | Dermal | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+00 | mg/L | 1.80E+00 | 5.96E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **8.94E-05** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Surface Water | Dermal | Arsenic | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 4.85E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 7.27E-06 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 3.41E+03 | mg/kg | 5.01E-03 | ug/m3 | 5.01E-03 | 9.52E-04 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 4.10E-06 |
| | | | | | | | | | | | **Cancer Risk** | **4.80E-02** |

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Uits | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 2.36E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.54E-03** |
| Large Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 1.66E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.50E-05** |
| Small Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 1.50E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.26E-04** |
| Birds | Ingestion | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 6.29E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **9.44E-04** |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 3.41E+03 | mg/kg | 2.04E+01 | mg/kg | 2.04E+01 | 2.23E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.35E-03** |
| | | | | | | | | | | | **Cancer Risk** | **8.08E-03** |

| | |
|---|---|
| **Total Excess Cancer Risk** | **5.61E-02** |

## Table D-4
## CALCULATION OF CANCER RISKS
## RED DEVIL MINE

Scenario Timeframe: Current/Future
Receptor Population: Recreational/Subsistence User
Receptor Age: Combined Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 1.42E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.13E-03** |
| Soil | Dermal | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 2.24E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.36E-04** |
| Sediment | Dermal | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.29E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.43E-03** |
| Surface Water | Ingestion | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E+02 | ug/L | 5.73E+02 | 4.87E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **7.30E-04** |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E+00 | ug/L | 1.50E+00 | 1.27E-06 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 3.70E-08 |
| Surface Water | Dermal | Arsenic | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 1.62E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 2.42E-06 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 5.88E+03 | mg/kg | 1.87E-03 | ug/m3 | 1.87E-03 | 1.19E-04 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 5.11E-07 |
| | | | | | | | | | | | **Cancer Risk** | **6.63E-03** |

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 4.72E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **7.08E-04** |
| Large Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 2.33E-07 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 3.49E-07 |
| Small Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 3.01E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 4.51E-06 |
| Birds | Ingestion | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 2.08E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.12E-04** |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 5.88E+03 | mg/kg | 3.53E+01 | mg/kg | 3.53E+01 | 3.86E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **5.79E-05** |
| | | | | | | | | | | | **Cancer Risk** | **1.08E-03** |

| | |
|---|---|
| **Total Excess Cancer Risk** | **7.72E-03** |

## Table D-5
## CALCULATION OF CANCER RISKS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Mine Worker
Receptor Age: Combined Adult

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 1.48E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.22E-03** |
| Soil | Dermal | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 3.19E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **4.78E-04** |
| Sediment | Dermal | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 1.49E-03 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.24E-03** |
| Groundwater | Ingestion | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+03 | ug/L | 1.80E+03 | 1.51E-02 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.27E-02** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 4.78E-05 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 6.69E-07 |
| Groundwater | Dermal | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+00 | mg/L | 1.80E+00 | 4.76E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **7.14E-05** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Surface Water | Dermal | Arsenic | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 3.27E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 4.90E-06 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 5.88E+03 | mg/kg | 8.65E-03 | ug/m3 | 8.65E-03 | 1.65E-03 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 7.08E-06 |
| | | | | | | | | | | | **Cancer Risk** | **2.77E-02** |

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 2.59E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.89E-04** |
| Large Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 1.27842E-07 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 1.92E-07 |
| Small Land Mammals | Ingestion | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 1.65E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 2.48E-06 |
| Birds | Ingestion | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 1.14E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **1.71E-04** |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 5.88E+03 | mg/kg | 3.53E+01 | mg/kg | 3.53E+01 | 2.12E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.18E-05** |
| | | | | | | | | | | | **Cancer Risk** | **5.94E-04** |

| | |
|---|---|
| **Total Excess Cancer Risk** | **2.83E-02** |

## Table D-6
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - SMA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Does Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Aluminum | 1.08E+04 | mg/kg | 1.08E+04 | mg/kg | 1.08E+04 | 1.14E-02 | 1.06E-01 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.1E-02 | 1.1E-01 |
| | | Antimony | 4.95E+01 | mg/kg | 4.95E+01 | mg/kg | 4.95E+01 | 5.23E-05 | 4.88E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 1.3E-01 | **1.2E+00** |
| | | Arsenic (inorganic) | 5.66E+03 | mg/kg | 5.66E+03 | mg/kg | 5.66E+03 | 3.59E-03 | 3.35E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.2E+01** | **1.1E+02** |
| | | Barium | 1.91E+02 | mg/kg | 1.91E+02 | mg/kg | 1.91E+02 | 2.02E-04 | 1.88E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.0E-03 | 9.4E-03 |
| | | Chromium | 2.24E+01 | mg/kg | 2.24E+01 | mg/kg | 2.24E+01 | 2.36E-05 | 2.21E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.6E-05 | 1.5E-04 |
| | | Cobalt | 1.79E+01 | mg/kg | 1.79E+01 | mg/kg | 1.79E+01 | 1.89E-05 | 1.76E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.3E-02 | 5.9E-01 |
| | | Iron | 4.01E+04 | mg/kg | 4.01E+04 | mg/kg | 4.01E+04 | 4.24E-02 | 3.96E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 6.1E-02 | 5.7E-01 |
| | | Manganese | 8.96E+02 | mg/kg | 8.96E+02 | mg/kg | 8.96E+02 | 9.47E-04 | 8.84E-03 | mg/kg-d | 2.4E-02 | mg/kg-d | 3.9E-02 | 3.7E-01 |
| | | Mercury | 3.94E+01 | mg/kg | 3.94E+01 | mg/kg | 3.94E+01 | 4.17E-05 | 3.89E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.4E-01 | **1.3E+00** |
| | | Thallium | 2.00E-01 | mg/kg | 2.00E-01 | mg/kg | 2.00E-01 | 2.11E-07 | 1.97E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | 2.1E-02 | 2.0E-01 |
| | | Vanadium | 3.56E+01 | mg/kg | 3.56E+01 | mg/kg | 3.56E+01 | 3.76E-05 | 3.51E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 7.5E-03 | 7.0E-02 |
| | | | | | | | | | | | | **Hazard Index** | **1.2E+01** | **1.2E+02** |
| Soil | Dermal | Aluminum | 1.08E+04 | mg/kg | 1.08E+04 | mg/kg | 1.08E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Antimony | 4.95E+01 | mg/kg | 4.95E+01 | mg/kg | 4.95E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 5.66E+03 | mg/kg | 5.66E+03 | mg/kg | 5.66E+03 | 7.16E-04 | 4.69E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.4E+00** | **1.6E+01** |
| | | Barium | 1.91E+02 | mg/kg | 1.91E+02 | mg/kg | 1.91E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Chromium | 2.24E+01 | mg/kg | 2.24E+01 | mg/kg | 2.24E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Cobalt | 1.79E+01 | mg/kg | 1.79E+01 | mg/kg | 1.79E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Iron | 4.01E+04 | mg/kg | 4.01E+04 | mg/kg | 4.01E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Manganese | 8.96E+02 | mg/kg | 8.96E+02 | mg/kg | 8.96E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Mercury | 3.94E+01 | mg/kg | 3.94E+01 | mg/kg | 3.94E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Thallium | 2.00E-01 | mg/kg | 2.00E-01 | mg/kg | 2.00E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Vanadium | 3.56E+01 | mg/kg | 3.56E+01 | mg/kg | 3.56E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **2.4E+00** | **1.6E+01** |
| Sediment | Dermal | Aluminum | 1.08E+04 | mg/kg | 1.08E+04 | mg/kg | 1.08E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Antimony | 4.46E+03 | mg/kg | 4.46E+03 | mg/kg | 4.46E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.53E-03 | 1.66E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **8.4E+00** | **5.5E+01** |
| | | Barium | 6.81E+02 | mg/kg | 6.81E+02 | mg/kg | 6.81E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Cadmium | 2.92E-01 | mg/kg | 2.92E-01 | mg/kg | 2.92E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.5E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Chromium | 2.57E+01 | mg/kg | 2.57E+01 | mg/kg | 2.57E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Cobalt | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Copper | 3.72E+01 | mg/kg | 3.72E+01 | mg/kg | 3.72E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 4.0E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Iron | 9.92E+04 | mg/kg | 9.92E+04 | mg/kg | 9.92E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Manganese | 2.02E+03 | mg/kg | 2.02E+03 | mg/kg | 2.02E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Mercury | 6.66E+01 | mg/kg | 6.66E+01 | mg/kg | 6.66E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Methyl Mercury | 5.23E-03 | mg/kg | 5.23E-03 | mg/kg | 5.23E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Nickel | 5.70E+01 | mg/kg | 5.70E+01 | mg/kg | 5.70E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 8.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Selenium | 4.87E-01 | mg/kg | 4.87E-01 | mg/kg | 4.87E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Silver | 1.14E-01 | mg/kg | 1.14E-01 | mg/kg | 1.14E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Thallium | 1.49E-01 | mg/kg | 1.49E-01 | mg/kg | 1.49E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Vanadium | 3.10E+01 | mg/kg | 3.10E+01 | mg/kg | 3.10E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Zinc | 9.16E+01 | mg/kg | 9.16E+01 | mg/kg | 9.16E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-01 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **8.4E+00** | **5.5E+01** |

## Table D-6
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - SMA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Does Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | Ingestion | Antimony | 1.21E+00 | ug/L | 1.21E+00 | ug/L | 1.21E+00 | 3.32E-05 | 7.74E-05 | mg/kg-d | 4.0E-04 | mg/kg-d | 8.3E-02 | 1.9E-01 |
| | | Arsenic (Inorganic) | 3.91E+01 | ug/L | 3.91E+01 | ug/L | 3.91E+01 | 1.07E-03 | 2.50E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.6E+00** | **8.3E+00** |
| | | Barium | 2.24E+02 | ug/L | 2.24E+02 | ug/L | 2.24E+02 | 6.14E-03 | 1.43E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 3.1E-02 | 7.2E-02 |
| | | Chromium | 1.06E+01 | ug/L | 1.06E+01 | ug/L | 1.06E+01 | 2.90E-04 | 6.78E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.9E-04 | 4.5E-04 |
| | | Cobalt | 9.48E+00 | ug/L | 9.48E+00 | ug/L | 9.48E+00 | 2.60E-04 | 6.06E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.7E-01 | **2.0E+00** |
| | | Iron | 2.67E+03 | ug/L | 2.67E+03 | ug/L | 2.67E+03 | 7.32E-02 | 1.71E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.0E-01 | 2.4E-01 |
| | | Manganese | 7.78E+02 | ug/L | 7.78E+02 | ug/L | 7.78E+02 | 2.13E-02 | 4.97E-02 | mg/kg-d | 2.4E-02 | mg/kg-d | 8.9E-01 | **2.1E+00** |
| | | Mercury | 2.47E-01 | ug/L | 2.47E-01 | ug/L | 2.47E-01 | 6.77E-06 | 1.58E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.3E-02 | 5.3E-02 |
| | | Nickel | 2.83E+01 | ug/L | 2.83E+01 | ug/L | 2.83E+01 | 7.75E-04 | 1.81E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 3.9E-02 | 9.0E-02 |
| | | Selenium | | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Thallium | 1.50E-02 | ug/L | 1.50E-02 | ug/L | 1.50E-02 | 4.11E-07 | 9.59E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 4.1E-02 | 9.6E-02 |
| | | Bis(2-ethylhexyl)phthalate | | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **5.6E+00** | **1.3E+01** |
| Groundwater | Dermal | Antimony | 1.21E+00 | ug/L | 1.21E-03 | mg/L | 1.21E-03 | 7.46E-08 | 1.68E-10 | mg/kg-d | 6.0E-05 | mg/kg-d | 1.2E-03 | 2.8E-06 |
| | | Arsenic (Inorganic) | 3.91E+01 | ug/L | 3.91E-02 | mg/L | 3.91E-02 | 2.41E-06 | 5.44E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.0E-03 | 1.8E-02 |
| | | Barium | 2.24E+02 | ug/L | 2.24E-01 | mg/L | 2.24E-01 | 1.38E-05 | 3.12E-05 | mg/kg-d | 1.4E-02 | mg/kg-d | 9.9E-04 | 2.2E-03 |
| | | Chromium | 1.06E+01 | ug/L | 1.06E-02 | mg/L | 1.06E-02 | 6.53E-07 | 1.48E-06 | mg/kg-d | 2.0E-02 | mg/kg-d | 3.3E-05 | 7.4E-05 |
| | | Cobalt | 9.48E+00 | ug/L | 9.48E-03 | mg/L | 9.48E-03 | 2.34E-07 | 5.28E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 7.8E-04 | 1.8E-03 |
| | | Iron | 2.67E+03 | ug/L | 2.67E+00 | mg/L | 2.67E+00 | 1.65E-04 | 3.72E-04 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.4E-04 | 5.3E-04 |
| | | Manganese | 7.78E+02 | ug/L | 7.78E-01 | mg/L | 7.78E-01 | 4.80E-05 | 1.08E-04 | mg/kg-d | 9.6E-04 | mg/kg-d | 5.0E-02 | 1.1E-01 |
| | | Mercury | 2.47E-01 | ug/L | 2.47E-04 | mg/L | 2.47E-04 | 1.52E-08 | 3.44E-08 | mg/kg-d | 2.1E-05 | mg/kg-d | 7.3E-04 | 1.6E-03 |
| | | Nickel | 2.83E+01 | ug/L | 2.83E-02 | mg/L | 2.83E-02 | 3.49E-07 | 7.88E-07 | mg/kg-d | 8.0E-04 | mg/kg-d | 4.4E-04 | 9.9E-04 |
| | | Selenium | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Thallium | 1.50E-02 | ug/L | 1.50E-05 | mg/L | 1.50E-05 | 9.25E-10 | 2.09E-09 | mg/kg-d | 1.0E-05 | mg/kg-d | 9.2E-05 | 2.1E-04 |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | 6.3E-02 | 1.4E-01 |
| Surface Water | Dermal | Antimony | 1.36E+02 | ug/L | 1.36E-01 | mg/L | 1.36E-01 | 1.80E-06 | 6.16E-06 | mg/kg-d | 6.0E-05 | mg/kg-d | 3.0E-02 | 1.0E-01 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 7.63E-06 | 2.60E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.5E-02 | 8.7E-02 |
| | | Cadmium | 6.00E-03 | ug/L | 6.00E-06 | mg/L | 6.00E-06 | 7.99E-11 | 2.73E-10 | mg/kg-d | 2.5E-05 | mg/kg-d | 3.2E-06 | 1.1E-05 |
| | | Cobalt | 3.04E+00 | ug/L | 3.04E-03 | mg/L | 3.04E-03 | 1.62E-08 | 5.53E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.4E-05 | 1.8E-04 |
| | | Copper | 4.31E-01 | ug/L | 4.31E-04 | mg/L | 4.31E-04 | 5.74E-09 | 1.96E-08 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.4E-07 | 4.9E-07 |
| | | Iron | 1.33E+03 | ug/L | 1.33E+00 | mg/L | 1.33E+00 | 1.76E-05 | 6.03E-05 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.5E-05 | 8.6E-05 |
| | | Manganese | 1.71E+02 | ug/L | 1.71E-01 | mg/L | 1.71E-01 | 2.27E-06 | 7.76E-06 | mg/kg-d | 9.6E-04 | mg/kg-d | 2.4E-03 | 8.1E-03 |
| | | Mercury | 2.41E-01 | ug/L | 2.41E-04 | mg/L | 2.41E-04 | 3.21E-09 | 1.10E-08 | mg/kg-d | 2.1E-05 | mg/kg-d | 1.5E-04 | 5.2E-04 |
| | | Methyl Mercury | 3.13E-04 | ug/L | 3.13E-07 | mg/L | 3.13E-07 | 4.17E-12 | 1.42E-11 | mg/kg-d | 1.0E-04 | mg/kg-d | 4.2E-08 | 1.4E-07 |
| | | Nickel | 1.05E+01 | ug/L | 1.05E-02 | mg/L | 1.05E-02 | 2.81E-08 | 9.59E-08 | mg/kg-d | 8.0E-04 | mg/kg-d | 3.5E-05 | 1.2E-04 |
| | | Selenium | 3.85E-01 | ug/L | 3.85E-04 | mg/L | 3.85E-04 | 5.13E-09 | 1.75E-08 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.0E-06 | 3.5E-06 |
| | | Silver | 2.60E-02 | ug/L | 2.60E-05 | mg/L | 2.60E-05 | 2.08E-10 | 7.09E-10 | mg/kg-d | 2.0E-04 | mg/kg-d | 1.0E-06 | 3.5E-06 |
| | | Zinc | 7.27E-01 | ug/L | 7.27E-04 | mg/L | 7.27E-04 | 5.81E-09 | 1.98E-08 | mg/kg-d | 3.0E-01 | mg/kg-d | 1.9E-08 | 6.6E-08 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-02 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Naphthalene | 6.80E-01 | ug/L | 6.80E-04 | mg/L | 6.80E-04 | 4.26E-07 | 1.45E-06 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.1E-05 | 7.3E-05 |
| | | | | | | | | | | | | **Hazard Index** | 5.8E-02 | 2.0E-01 |
| Air | Dust Particulates or Volatile from Soil | Aluminum | 1.08E+04 | mg/kg | 1.59E-05 | mg/m3 | 1.59E-05 | 1.17E-05 | 1.17E-05 | mg/m3 | 5.0E-03 | mg/m3 | 2.3E-03 | 2.3E-03 |
| | | Antimony | 4.95E+01 | mg/kg | 7.28E-08 | mg/m3 | 7.28E-08 | 5.38E-08 | 5.38E-08 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Arsenic (inorganic) | 5.66E+03 | mg/kg | 8.32E-06 | mg/m3 | 8.32E-06 | 3.69E-06 | 3.69E-06 | mg/m3 | 1.5E-05 | mg/m3 | 2.5E-01 | 2.5E-01 |
| | | Barium | 1.91E+02 | mg/kg | 2.81E-07 | mg/m3 | 2.81E-07 | 2.08E-07 | 2.08E-07 | mg/m3 | 5.0E-04 | mg/m3 | 4.2E-04 | 4.2E-04 |
| | | Chromium | 2.24E+01 | mg/kg | 3.29E-08 | mg/m3 | 3.29E-08 | 2.43E-08 | 2.43E-08 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Cobalt | 1.79E+01 | mg/kg | 2.63E-08 | mg/m3 | 2.63E-08 | 1.94E-08 | 1.94E-08 | mg/m3 | 6.0E-06 | mg/m3 | 3.2E-03 | 3.2E-03 |
| | | Iron | 4.01E+04 | mg/kg | 5.90E-05 | mg/m3 | 5.90E-05 | 4.37E-05 | 4.37E-05 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Manganese | 8.96E+02 | mg/kg | 1.32E-06 | mg/m3 | 1.32E-06 | 9.75E-07 | 9.75E-07 | mg/m3 | 5.0E-05 | mg/m3 | 1.9E-02 | 1.9E-02 |
| | | Mercury | 3.94E+01 | mg/kg | 1.77E-03 | mg/m3 | 1.77E-03 | 1.31E-03 | 1.31E-03 | mg/m3 | 3.0E-04 | mg/m3 | **4.4E+00** | **4.4E+00** |
| | | Thallium | 2.00E-01 | mg/kg | 2.94E-10 | mg/m3 | 2.94E-10 | 2.18E-10 | 2.18E-10 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Vanadium | 3.56E+01 | mg/kg | 5.23E-08 | mg/m3 | 5.23E-08 | 3.87E-08 | 3.87E-08 | mg/m3 | -- | mg/m3 | -- | -- |
| | | | | | | | | | | | | **Hazard Index** | **4.6E+00** | **4.6E+00** |
| Air | Volatile from Groundwater | Mercury | 2.47E-01 | ug/L | 1.24E-04 | mg/m3 | 1.24E-04 | 3.70E-06 | 3.70E-06 | mg/m3 | 3.0E-04 | mg/m3 | 1.2E-02 | 1.2E-02 |

# Table D-6
# CALCULATION OF NON-CANCER HAZARDS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - SMA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Does Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Aluminum | 3.22E+01 | mg/kg | 3.22E+01 | mg/kg | 3.22E+01 | 1.25E-01 | 2.80E-01 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.2E-01 | 2.8E-01 |
| | | Antimony | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 6.60E-02 | 1.48E-01 | mg/kg-d | 4.0E-04 | mg/kg-d | **1.7E+02** | **3.7E+02** |
| | | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 4.41E-03 | 9.89E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.5E+01** | **3.3E+01** |
| | | Barium | 3.79E+00 | mg/kg | 3.79E+00 | mg/kg | 3.79E+00 | 1.47E-02 | 3.28E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 7.3E-02 | 1.6E-01 |
| | | Cadmium | 4.42E-02 | mg/kg | 4.42E-02 | mg/kg | 4.42E-02 | 1.71E-04 | 3.83E-04 | mg/kg-d | 1.0E-03 | mg/kg-d | 1.7E-01 | 3.8E-01 |
| | | Chromium | 6.80E-01 | mg/kg | 6.80E-01 | mg/kg | 6.80E-01 | 2.63E-03 | 5.90E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.8E-03 | 3.9E-03 |
| | | Cobalt | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Copper | 1.25E+00 | mg/kg | 1.25E+00 | mg/kg | 1.25E+00 | 4.85E-03 | 1.09E-02 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.2E-01 | 2.7E-01 |
| | | Iron | 8.89E+01 | mg/kg | 8.89E+01 | mg/kg | 8.89E+01 | 3.44E-01 | 7.71E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 4.9E-01 | **1.1E+00** |
| | | Manganese | 1.25E+01 | mg/kg | 1.25E+01 | mg/kg | 1.25E+01 | 4.84E-02 | 1.08E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | 3.5E-01 | 7.7E-01 |
| | | Mercury | 2.14E+00 | mg/kg | 6.42E+00 | mg/kg | 6.42E+00 | 2.49E-02 | 5.57E-02 | mg/kg-d | 1.0E-04 | mg/kg-d | **2.5E+02** | **5.6E+02** |
| | | Nickel | 1.47E-01 | mg/kg | 1.47E-01 | mg/kg | 1.47E-01 | 5.69E-04 | 1.27E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.8E-02 | 6.4E-02 |
| | | Selenium | 1.89E+00 | mg/kg | 1.89E+00 | mg/kg | 1.89E+00 | 7.32E-03 | 1.64E-02 | mg/kg-d | 5.0E-03 | mg/kg-d | **1.5E+00** | **3.3E+00** |
| | | Silver | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Thallium | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.0E+00 | 0.0E+00 |
| | | Vanadium | 2.21E-01 | mg/kg | 2.21E-01 | mg/kg | 2.21E-01 | 8.56E-04 | 1.92E-03 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.7E-01 | 3.8E-01 |
| | | Zinc | 2.66E+01 | mg/kg | 2.66E+01 | mg/kg | 2.66E+01 | 1.03E-01 | 2.30E-01 | mg/kg-d | 3.0E-01 | mg/kg-d | 3.4E-01 | 7.7E-01 |
| | | | | | | | | | | | | **Hazard Index** | **4.3E+02** | **9.7E+02** |
| Large Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 6.43E-01 | mg/kg | 6.43E-01 | 6.96E-04 | 1.56E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 7.0E-04 | 1.6E-03 |
| | | Antimony | 2.72E+00 | mg/kg | 7.35E-02 | mg/kg | 7.35E-02 | 7.96E-05 | 1.78E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 2.0E-01 | 4.5E-01 |
| | | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 3.11E-05 | 6.97E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.0E-01 | 2.3E-01 |
| | | Barium | 1.55E+02 | mg/kg | 6.29E-01 | mg/kg | 6.29E-01 | 6.81E-04 | 1.52E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 3.4E-03 | 7.6E-03 |
| | | Chromium | 8.55E-01 | mg/kg | 1.27E-01 | mg/kg | 1.27E-01 | 1.37E-04 | 3.08E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 9.2E-05 | 2.1E-04 |
| | | Cobalt | 3.35E-01 | mg/kg | 1.81E-01 | mg/kg | 1.81E-01 | 1.96E-04 | 4.39E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.5E-01 | **1.5E+00** |
| | | Iron | 2.96E+01 | mg/kg | 1.60E+01 | mg/kg | 1.60E+01 | 1.73E-02 | 3.87E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.5E-02 | 5.5E-02 |
| | | Manganese | 7.15E+02 | mg/kg | 7.72E+00 | mg/kg | 7.72E+00 | 8.36E-03 | 1.87E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 6.0E-02 | 1.3E-01 |
| | | Mercury | 2.10E-01 | mg/kg | 1.42E+00 | mg/kg | 1.42E+00 | 1.53E-03 | 3.44E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **5.1E+00** | **1.1E+01** |
| | | Thallium | 1.62E-02 | mg/kg | 1.75E-02 | mg/kg | 1.75E-02 | 1.89E-05 | 4.24E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | **1.9E+00** | **4.2E+00** |
| | | Vanadium | 6.45E-02 | mg/kg | 4.35E-03 | mg/kg | 4.35E-03 | 4.71E-06 | 1.06E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 9.4E-04 | 2.1E-03 |
| | | | | | | | | | | | | **Hazard Index** | **8.1E+00** | **1.8E+01** |
| Small Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 1.59E+01 | mg/kg | 1.59E+01 | 8.39E-03 | 1.88E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 8.4E-03 | 1.9E-02 |
| | | Antimony | 2.72E+00 | mg/kg | 2.72E+00 | mg/kg | 2.72E+00 | 1.44E-03 | 3.23E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **3.6E+00** | **8.1E+00** |
| | | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 2.81E-04 | 6.30E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.4E-01 | **2.1E+00** |
| | | Barium | 1.55E+02 | mg/kg | 1.55E+02 | mg/kg | 1.55E+02 | 8.20E-02 | 1.84E-01 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.1E-01 | 9.2E-01 |
| | | Chromium | 8.55E-01 | mg/kg | 8.55E-01 | mg/kg | 8.55E-01 | 4.52E-04 | 1.01E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | 3.0E-04 | 6.7E-04 |
| | | Cobalt | 3.35E-01 | mg/kg | 3.35E-01 | mg/kg | 3.35E-01 | 1.77E-04 | 3.97E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.9E-01 | **1.3E+00** |
| | | Iron | 2.96E+01 | mg/kg | 2.96E+01 | mg/kg | 2.96E+01 | 1.56E-02 | 3.50E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.2E-02 | 5.0E-02 |
| | | Manganese | 7.15E+02 | mg/kg | 7.15E+02 | mg/kg | 7.15E+02 | 3.78E-01 | 8.46E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | **2.7E+00** | **6.0E+00** |
| | | Mercury | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 1.11E-04 | 2.49E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.7E-01 | 8.3E-01 |
| | | Thallium | 1.62E-02 | mg/kg | 1.62E-02 | mg/kg | 1.62E-02 | 8.56E-06 | 1.92E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | 8.6E-01 | **1.9E+00** |
| | | Vanadium | 6.45E-02 | mg/kg | 6.45E-02 | mg/kg | 6.45E-02 | 3.41E-05 | 7.64E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.8E-03 | 1.5E-02 |
| | | | | | | | | | | | | **Hazard Index** | **9.5E+00** | **2.1E+01** |

# Table D-6
# CALCULATION OF NON-CANCER HAZARDS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - SMA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Does Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birds | Ingestion | Aluminum | 1.30E+02 | mg/kg | 1.30E+02 | mg/kg | 1.30E+02 | 2.01E-02 | 4.50E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 2.0E-02 | 4.5E-02 |
| | | Antimony | 1.03E+01 | mg/kg | 1.03E+01 | mg/kg | 1.03E+01 | 1.60E-03 | 3.59E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **4.0E+00** | **9.0E+00** |
| | | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 1.18E-03 | 2.64E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.9E+00** | **8.8E+00** |
| | | Barium | 5.99E+01 | mg/kg | 5.99E+01 | mg/kg | 5.99E+01 | 9.30E-03 | 2.08E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.6E-02 | 1.0E-01 |
| | | Chromium | 8.35E-01 | mg/kg | 8.35E-01 | mg/kg | 8.35E-01 | 1.30E-04 | 2.90E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 8.6E-05 | 1.9E-04 |
| | | Cobalt | 2.33E-01 | mg/kg | 2.33E-01 | mg/kg | 2.33E-01 | 3.62E-05 | 8.10E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.2E-01 | 2.7E-01 |
| | | Iron | 1.97E+02 | mg/kg | 1.97E+02 | mg/kg | 1.97E+02 | 3.06E-02 | 6.86E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 4.4E-02 | 9.8E-02 |
| | | Manganese | 1.90E+03 | mg/kg | 1.90E+03 | mg/kg | 1.90E+03 | 2.96E-01 | 6.62E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | **2.1E+00** | **4.7E+00** |
| | | Mercury | 5.64E+00 | mg/kg | 5.64E+00 | mg/kg | 5.64E+00 | 8.76E-04 | 1.96E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.9E+00** | **6.5E+00** |
| | | Thallium | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 3.26E-05 | 7.30E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | **3.3E+00** | **7.3E+00** |
| | | Vanadium | 9.17E-01 | mg/kg | 9.17E-01 | mg/kg | 9.17E-01 | 1.42E-04 | 3.19E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.8E-02 | 6.4E-02 |
| | | | | | | | | | | | | **Hazard Index** | **1.6E+01** | **3.7E+01** |
| Berries and Plants | Ingestion | Aluminum | 1.08E+04 | mg/kg | 7.01E+00 | mg/kg | 7.01E+00 | 1.43E-03 | 3.21E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.4E-03 | 3.2E-03 |
| | | Antimony | 4.95E+01 | mg/kg | 1.48E+00 | mg/kg | 1.48E+00 | 3.03E-04 | 6.79E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 7.6E-01 | **1.7E+00** |
| | | Arsenic (inorganic) | 5.66E+03 | mg/kg | 3.40E+01 | mg/kg | 3.40E+01 | 6.94E-03 | 1.55E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.3E+01** | **5.2E+01** |
| | | Barium | 1.91E+02 | mg/kg | 2.87E+00 | mg/kg | 2.87E+00 | 5.85E-04 | 1.31E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 2.9E-03 | 6.6E-03 |
| | | Chromium | 2.24E+01 | mg/kg | 1.01E-01 | mg/kg | 1.01E-01 | 2.06E-05 | 4.60E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.4E-05 | 3.1E-05 |
| | | Cobalt | 1.79E+01 | mg/kg | 1.25E-01 | mg/kg | 1.25E-01 | 2.55E-05 | 5.72E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.5E-02 | 1.9E-01 |
| | | Iron | 4.01E+04 | mg/kg | 4.01E+01 | mg/kg | 4.01E+01 | 8.20E-03 | 1.84E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.2E-02 | 2.6E-02 |
| | | Manganese | 8.96E+02 | mg/kg | 4.48E+01 | mg/kg | 4.48E+01 | 9.15E-03 | 2.05E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 6.5E-02 | 1.5E-01 |
| | | Mercury | 3.94E+01 | mg/kg | 7.89E+00 | mg/kg | 7.89E+00 | 1.61E-03 | 3.61E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **5.4E+00** | **1.2E+01** |
| | | Thallium | 2.00E-01 | mg/kg | 8.00E-05 | mg/kg | 8.00E-05 | 1.63E-08 | 3.66E-08 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.6E-03 | 3.7E-03 |
| | | Vanadium | 3.56E+01 | mg/kg | 1.07E-01 | mg/kg | 1.07E-01 | 2.18E-05 | 4.89E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 4.4E-03 | 9.8E-03 |
| | | | | | | | | | | | | **Hazard Index** | **2.9E+01** | **6.6E+01** |

| | | |
|---|---|---|
| **Total Hazard Index** | **5.3E+02** | **1.3E+03** |

# Table D-7
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - MPA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Aluminum | 9.36E+03 | mg/kg | 9.36E+03 | mg/kg | 9.36E+03 | 9.90E-03 | 9.24E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 9.90E-03 | 9.2E-02 |
| | | Antimony | 4.52E+03 | mg/kg | 4.52E+03 | mg/kg | 4.52E+03 | 4.77E-03 | 4.45E-02 | mg/kg-d | 4.0E-04 | mg/kg-d | **1.19E+01** | **1.1E+02** |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 7.80E+03 | mg/kg | 7.80E+03 | mg/kg | 7.80E+03 | 4.95E-03 | 4.62E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.65E+01** | **1.5E+02** |
| | | Barium | 3.79E+02 | mg/kg | 3.79E+02 | mg/kg | 3.79E+02 | 4.01E-04 | 3.74E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 2.00E-03 | 1.9E-02 |
| | | Chromium | 2.41E+01 | mg/kg | 2.41E+01 | mg/kg | 2.41E+01 | 2.54E-05 | 2.37E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.70E-05 | 1.6E-04 |
| | | Cobalt | 1.61E+01 | mg/kg | 1.61E+01 | mg/kg | 1.61E+01 | 1.70E-05 | 1.59E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.68E-02 | 5.3E-01 |
| | | Iron | 3.71E+04 | mg/kg | 3.71E+04 | mg/kg | 3.71E+04 | 3.92E-02 | 3.66E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 5.60E-02 | 5.2E-01 |
| | | Manganese | 7.28E+02 | mg/kg | 7.28E+02 | mg/kg | 7.28E+02 | 7.69E-04 | 7.18E-03 | mg/kg-d | 2.4E-02 | mg/kg-d | 3.21E-02 | 3.0E-01 |
| | | Mercury | 5.06E+02 | mg/kg | 5.06E+02 | mg/kg | 5.06E+02 | 5.35E-04 | 4.99E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.78E+00** | **1.7E+01** |
| | | Thallium | 1.74E-01 | mg/kg | 1.74E-01 | mg/kg | 1.74E-01 | 1.84E-07 | 1.72E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.84E-02 | 1.7E-01 |
| | | Vanadium | 2.98E+01 | mg/kg | 2.98E+01 | mg/kg | 2.98E+01 | 3.15E-05 | 2.94E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.30E-03 | 5.9E-02 |
| | | Naphthalene | 5.05E+02 | mg/kg | 5.05E+02 | mg/kg | 5.05E+02 | 5.33E-04 | 4.98E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.67E-02 | 2.5E-01 |
| | | | | | | | | | | | | **Hazard Index** | **3.04E+01** | **2.84E+02** |
| Sediment | Dermal | Aluminum | 9.36E+03 | mg/kg | 9.36E+03 | mg/kg | 9.36E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Antimony | 4.52E+03 | mg/kg | 4.52E+03 | mg/kg | 4.52E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 7.80E+03 | mg/kg | 7.80E+03 | mg/kg | 7.80E+03 | 9.87E-04 | 6.47E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.29E+00** | **2.2E+01** |
| | | Barium | 3.79E+02 | mg/kg | 3.79E+02 | mg/kg | 3.79E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Chromium | 2.41E+01 | mg/kg | 2.41E+01 | mg/kg | 2.41E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.61E+01 | mg/kg | 1.61E+01 | mg/kg | 1.61E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Iron | 3.71E+04 | mg/kg | 3.71E+04 | mg/kg | 3.71E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Manganese | 7.28E+02 | mg/kg | 7.28E+02 | mg/kg | 7.28E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Mercury | 5.06E+02 | mg/kg | 5.06E+02 | mg/kg | 5.06E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | 1.74E-01 | mg/kg | 1.74E-01 | mg/kg | 1.74E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 2.98E+01 | mg/kg | 2.98E+01 | mg/kg | 2.98E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Naphthalene | 5.05E+02 | mg/kg | 5.05E+02 | mg/kg | 5.05E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **3.29E+00** | **2.16E+01** |
| | Dermal | Aluminum | 1.08E+04 | mg/kg | 1.08E+04 | mg/kg | 1.08E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Antimony | 4.46E+03 | mg/kg | 4.46E+03 | mg/kg | 4.46E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.53E-03 | 1.66E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **8.43E+00** | **5.5E+01** |
| | | Barium | 6.81E+02 | mg/kg | 6.81E+02 | mg/kg | 6.81E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cadmium | 2.92E-01 | mg/kg | 2.92E-01 | mg/kg | 2.92E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.5E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |

## Table D-7
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - MPA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | Dermal | Chromium | 2.57E+01 | mg/kg | 2.57E+01 | mg/kg | 2.57E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Copper | 3.72E+01 | mg/kg | 3.72E+01 | mg/kg | 3.72E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 4.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Iron | 9.92E+04 | mg/kg | 9.92E+04 | mg/kg | 9.92E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Manganese | 2.02E+03 | mg/kg | 2.02E+03 | mg/kg | 2.02E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Mercury | 6.66E+01 | mg/kg | 6.66E+01 | mg/kg | 6.66E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Methyl Mercury | 5.23E-03 | mg/kg | 5.23E-03 | mg/kg | 5.23E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Nickel | 5.70E+01 | mg/kg | 5.70E+01 | mg/kg | 5.70E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 8.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Selenium | 4.87E-01 | mg/kg | 4.87E-01 | mg/kg | 4.87E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Silver | 1.14E-01 | mg/kg | 1.14E-01 | mg/kg | 1.14E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | 1.49E-01 | mg/kg | 1.49E-01 | mg/kg | 1.49E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 3.10E+01 | mg/kg | 3.10E+01 | mg/kg | 3.10E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Zinc | 9.16E+01 | mg/kg | 9.16E+01 | mg/kg | 9.16E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **8.43E+00** | **5.52E+01** |
| Groundwater | Ingestion | Antimony | 5.61E+03 | ug/L | 5.61E+03 | ug/L | 5.61E+03 | 1.54E-01 | 3.59E-01 | mg/kg-d | 4.0E-04 | mg/kg-d | **3.84E+02** | **9.0E+02** |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+03 | ug/L | 1.80E+03 | 4.94E-02 | 1.15E-01 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.65E+02** | **3.8E+02** |
| | | Barium | 1.01E+02 | ug/L | 1.01E+02 | ug/L | 1.01E+02 | 2.76E-03 | 6.43E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.38E-02 | 3.2E-02 |
| | | Chromium | 3.51E+00 | ug/L | 3.51E+00 | ug/L | 3.51E+00 | 9.61E-05 | 2.24E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 6.40E-05 | 1.5E-04 |
| | | Cobalt | 9.79E+00 | ug/L | 9.79E+00 | ug/L | 9.79E+00 | 2.68E-04 | 6.26E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.94E-01 | **2.1E+00** |
| | | Iron | 8.04E+03 | ug/L | 8.04E+03 | ug/L | 8.04E+03 | 2.20E-01 | 5.14E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 3.15E-01 | 7.3E-01 |
| | | Manganese | 2.24E+03 | ug/L | 2.24E+03 | ug/L | 2.24E+03 | 6.15E-02 | 1.43E-01 | mg/kg-d | 2.4E-02 | mg/kg-d | **2.56E+00** | **6.0E+00** |
| | | Mercury | 1.48E+01 | ug/L | 1.48E+01 | ug/L | 1.48E+01 | 4.05E-04 | 9.45E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.35E+00** | **3.2E+00** |
| | | Nickel | 1.73E+01 | ug/L | 1.73E+01 | ug/L | 1.73E+01 | 4.74E-04 | 1.11E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.37E-02 | 5.5E-02 |
| | | Selenium | 9.17E-01 | ug/L | 9.17E-01 | ug/L | 9.17E-01 | 2.51E-05 | 5.86E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 5.02E-03 | 1.2E-02 |
| | | Thallium | 1.71E-02 | ug/L | 1.71E-02 | ug/L | 1.71E-02 | 4.68E-07 | 1.09E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | 4.68E-02 | 1.1E-01 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 1.56E-04 | 3.64E-04 | mg/kg-d | 2.0E-02 | mg/kg-d | 7.81E-03 | 1.8E-02 |
| | | | | | | | | | | | | **Hazard Index** | **5.54E+02** | **1.29E+03** |
| Surface Water | Dermal | Antimony | 5.61E+03 | ug/L | 5.61E+00 | mg/L | 5.61E+00 | 3.46E-04 | 7.81E-07 | mg/kg-d | 6.0E-05 | mg/kg-d | **5.76E+00** | 1.3E-02 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+00 | mg/L | 1.80E+00 | 1.11E-04 | 2.51E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.70E-01 | 8.4E-01 |
| | | Barium | 1.01E+02 | ug/L | 1.01E-01 | mg/L | 1.01E-01 | 6.20E-06 | 1.40E-05 | mg/kg-d | 1.4E-02 | mg/kg-d | 4.43E-04 | 1.0E-03 |
| | | Chromium | 3.51E+00 | ug/L | 3.51E-03 | mg/L | 3.51E-03 | 2.16E-07 | 4.88E-07 | mg/kg-d | 2.0E-02 | mg/kg-d | 1.08E-05 | 2.4E-05 |
| | | Cobalt | 9.79E+00 | ug/L | 9.79E-03 | mg/L | 9.79E-03 | 2.41E-07 | 5.45E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.04E-04 | 1.8E-03 |
| | | Iron | 8.04E+03 | ug/L | 8.04E+00 | mg/L | 8.04E+00 | 4.96E-04 | 1.12E-03 | mg/kg-d | 7.0E-01 | mg/kg-d | 7.08E-04 | 1.6E-03 |
| | | Manganese | 2.24E+03 | ug/L | 2.24E+00 | mg/L | 2.24E+00 | 1.38E-04 | 3.12E-04 | mg/kg-d | 9.6E-04 | mg/kg-d | 1.44E-01 | 3.3E-01 |
| | | Mercury | 1.48E+01 | ug/L | 1.48E-02 | mg/L | 1.48E-02 | 9.12E-07 | 2.06E-06 | mg/kg-d | 2.1E-05 | mg/kg-d | 4.34E-02 | 9.8E-02 |
| | | Nickel | 1.73E+01 | ug/L | 1.73E-02 | mg/L | 1.73E-02 | 2.13E-07 | 4.81E-07 | mg/kg-d | 8.0E-04 | mg/kg-d | 2.66E-04 | 6.0E-04 |
| | | Selenium | 9.17E-01 | ug/L | 9.17E-04 | mg/L | 9.17E-04 | 5.65E-08 | 1.28E-07 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.13E-05 | 2.6E-05 |
| | | Thallium | 1.71E-02 | ug/L | 1.71E-05 | mg/L | 1.71E-05 | 1.05E-09 | 2.38E-09 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.05E-04 | 2.4E-04 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **6.32E+00** | **1.28E+00** |
| | | Antimony | 1.36E+02 | ug/L | 1.36E-01 | mg/L | 1.36E-01 | 1.80E-06 | 6.16E-06 | mg/kg-d | 6.0E-05 | mg/kg-d | 3.01E-02 | 1.0E-01 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 7.63E-06 | 2.60E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.54E-02 | 8.7E-02 |

# Table D-7
# CALCULATION OF NON-CANCER HAZARDS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - MPA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Air | Dermal | Cadmium | 6.00E-03 | ug/L | 6.00E-06 | mg/L | 6.00E-06 | 7.99E-11 | 2.73E-10 | mg/kg-d | 2.5E-05 | mg/kg-d | 3.20E-06 | 1.1E-05 |
| | | Cobalt | 3.04E+00 | ug/L | 3.04E-03 | mg/L | 3.04E-03 | 1.62E-08 | 5.53E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.40E-05 | 1.8E-04 |
| | | Copper | 4.31E-01 | ug/L | 4.31E-04 | mg/L | 4.31E-04 | 5.74E-09 | 1.96E-08 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.44E-07 | 4.9E-07 |
| | | Iron | 1.33E+03 | ug/L | 1.33E+00 | mg/L | 1.33E+00 | 1.76E-05 | 6.03E-05 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.52E-05 | 8.6E-05 |
| | | Manganese | 1.71E+02 | ug/L | 1.71E-01 | mg/L | 1.71E-01 | 2.27E-06 | 7.76E-06 | mg/kg-d | 9.6E-04 | mg/kg-d | 2.37E-03 | 8.1E-03 |
| | | Mercury | 2.41E-01 | ug/L | 2.41E-04 | mg/L | 2.41E-04 | 3.21E-09 | 1.10E-08 | mg/kg-d | 2.1E-05 | mg/kg-d | 1.53E-04 | 5.2E-04 |
| | | Methyl Mercury | 3.13E-04 | ug/L | 3.13E-07 | mg/L | 3.13E-07 | 4.17E-12 | 1.42E-11 | mg/kg-d | 1.0E-04 | mg/kg-d | 4.17E-08 | 1.4E-07 |
| | | Nickel | 1.05E+01 | ug/L | 1.05E-02 | mg/L | 1.05E-02 | 2.81E-08 | 9.59E-08 | mg/kg-d | 8.0E-04 | mg/kg-d | 3.51E-05 | 1.2E-04 |
| | | Selenium | 3.85E-01 | ug/L | 3.85E-04 | mg/L | 3.85E-04 | 5.13E-09 | 1.75E-08 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.03E-06 | 3.5E-06 |
| | | Silver | 2.60E-02 | ug/L | 2.60E-05 | mg/L | 2.60E-05 | 2.08E-10 | 7.09E-10 | mg/kg-d | 2.0E-04 | mg/kg-d | 1.04E-06 | 3.5E-06 |
| | | Zinc | 7.27E-01 | ug/L | 7.27E-04 | mg/L | 7.27E-04 | 5.81E-09 | 1.98E-08 | mg/kg-d | 3.0E-01 | mg/kg-d | 1.94E-08 | 6.6E-08 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Naphthalene | 6.80E-01 | ug/L | 6.80E-04 | mg/L | 6.80E-04 | 4.26E-07 | 1.45E-06 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.13E-05 | 7.3E-05 |
| | | | | | | | | | | | | **Hazard Index** | 5.82E-02 | 1.99E-01 |
| Non-Salmon Fish | Dust Particulates or Volatile from Soil | Aluminum | 9.36E+03 | mg/kg | 1.38E-05 | mg/m3 | 1.38E-05 | 1.02E-05 | 1.02E-05 | mg/m3 | 5.0E-03 | mg/m3 | 2.04E-03 | 2.0E-03 |
| | | Antimony | 4.52E+03 | mg/kg | 6.64E-06 | mg/m3 | 6.64E-06 | 4.91E-06 | 4.91E-06 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/m3 | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/m3 | 1.5E-05 | mg/m3 | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 7.80E+03 | mg/kg | 1.15E-05 | mg/m3 | 1.15E-05 | 5.09E-06 | 5.09E-06 | mg/m3 | 1.5E-05 | mg/m3 | 3.40E-01 | 3.4E-01 |
| | | Barium | 3.79E+02 | mg/kg | 5.57E-07 | mg/m3 | 5.57E-07 | 4.12E-07 | 4.12E-07 | mg/m3 | 5.0E-04 | mg/m3 | 8.25E-04 | 8.2E-04 |
| | | Chromium | 2.41E+01 | mg/kg | 3.54E-08 | mg/m3 | 3.54E-08 | 2.62E-08 | 2.62E-08 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Cobalt | 1.61E+01 | mg/kg | 2.37E-08 | mg/m3 | 2.37E-08 | 1.75E-08 | 1.75E-08 | mg/m3 | 6.0E-06 | mg/m3 | 2.92E-03 | 2.9E-03 |
| | | Iron | 3.71E+04 | mg/kg | 5.46E-05 | mg/m3 | 5.46E-05 | 4.04E-05 | 4.04E-05 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Manganese | 7.28E+02 | mg/kg | 1.07E-06 | mg/m3 | 1.07E-06 | 7.92E-07 | 7.92E-07 | mg/m3 | 5.0E-05 | mg/m3 | 1.58E-02 | 1.6E-02 |
| | | Mercury | 5.06E+02 | mg/kg | 2.27E-02 | mg/m3 | 2.27E-02 | 1.68E-02 | 1.68E-02 | mg/m3 | 3.0E-04 | mg/m3 | **5.59E+01** | **5.6E+01** |
| | | Thallium | 1.74E-01 | mg/kg | 2.56E-10 | mg/m3 | 2.56E-10 | 1.89E-10 | 1.89E-10 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Vanadium | 2.98E+01 | mg/kg | 4.38E-08 | mg/m3 | 4.38E-08 | 3.24E-08 | 3.24E-08 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Naphthalene | 5.05E+02 | mg/kg | 7.42E-07 | mg/m3 | 7.42E-07 | 5.49E-07 | 5.49E-07 | mg/m3 | 3.0E-03 | mg/m3 | 1.83E-04 | 1.8E-04 |
| | | | | | | | | | | | | **Hazard Index** | **5.63E+01** | **5.63E+01** |
| | Volatile from Groundwater | Mercury | 1.48E+01 | ug/L | 7.39E-03 | mg/m3 | 7.39E-03 | 2.22E-04 | 2.22E-04 | mg/m3 | 3.0E-04 | mg/m3 | 7.39E-01 | 7.4E-01 |
| | Ingestion | Aluminum | 3.22E+01 | mg/kg | 3.22E+01 | mg/kg | 3.22E+01 | 1.25E-01 | 2.80E-01 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.25E-01 | 2.8E-01 |
| | | Antimony | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 6.60E-02 | 1.48E-01 | mg/kg-d | 4.0E-04 | mg/kg-d | **1.65E+02** | **3.7E+02** |
| | | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 4.41E-03 | 9.89E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.47E+01** | **3.3E+01** |
| | | Arsenic (Inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 3.79E+00 | mg/kg | 3.79E+00 | mg/kg | 3.79E+00 | 1.47E-02 | 3.28E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 7.33E-02 | 1.6E-01 |
| Large Land Mammal | | Cadmium | 4.42E-02 | mg/kg | 4.42E-02 | mg/kg | 4.42E-02 | 1.71E-04 | 3.83E-04 | mg/kg-d | 1.0E-03 | mg/kg-d | 1.71E-01 | 3.8E-01 |
| | | Chromium | 6.80E-01 | mg/kg | 6.80E-01 | mg/kg | 6.80E-01 | 2.63E-03 | 5.90E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.76E-03 | 3.9E-03 |
| | | Cobalt | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Copper | 1.25E+00 | mg/kg | 1.25E+00 | mg/kg | 1.25E+00 | 4.85E-03 | 1.09E-02 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.21E-01 | 2.7E-01 |
| | | Iron | 8.89E+01 | mg/kg | 8.89E+01 | mg/kg | 8.89E+01 | 3.44E-01 | 7.71E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 4.92E-01 | **1.1E+00** |
| | | Manganese | 1.25E+01 | mg/kg | 1.25E+01 | mg/kg | 1.25E+01 | 4.84E-02 | 1.08E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | 3.46E-01 | 7.7E-01 |
| | | Mercury | 2.14E+00 | mg/kg | 6.42E+00 | mg/kg | 6.42E+00 | 2.49E-02 | 5.57E-02 | mg/kg-d | 1.0E-04 | mg/kg-d | **2.49E+02** | **5.6E+02** |
| | | Methyl Mercury | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | | mg/kg-d | | |
| | | Nickel | 1.47E-01 | mg/kg | 1.47E-01 | mg/kg | 1.47E-01 | 5.69E-04 | 1.27E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.85E-02 | 6.4E-02 |
| | | Selenium | 1.89E+00 | mg/kg | 1.89E+00 | mg/kg | 1.89E+00 | 7.32E-03 | 1.64E-02 | mg/kg-d | 5.0E-03 | mg/kg-d | **1.46E+00** | **3.3E+00** |

## Table D-7
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - MPA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Large Land Mammal | Ingestion | Silver | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 2.21E-01 | mg/kg | 2.21E-01 | mg/kg | 2.21E-01 | 8.56E-04 | 1.92E-03 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.71E-01 | 3.8E-01 |
| | | Zinc | 2.66E+01 | mg/kg | 2.66E+01 | mg/kg | 2.66E+01 | 1.03E-01 | 2.30E-01 | mg/kg-d | 3.0E-01 | mg/kg-d | 3.43E-01 | 7.7E-01 |
| | | | | | | | | | | | | **Hazard Index** | **4.32E+02** | **9.67E+02** |

## Table D-7
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - MPA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Small Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 6.43E-01 | mg/kg | 6.43E-01 | 6.96E-04 | 1.56E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 6.96E-04 | 1.6E-03 |
| | | Antimony | 2.72E+00 | mg/kg | 7.35E-02 | mg/kg | 7.35E-02 | 7.96E-05 | 1.78E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 1.99E-01 | 4.5E-01 |
| | | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 3.11E-05 | 6.97E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.04E-01 | 2.3E-01 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 1.55E+02 | mg/kg | 6.29E-01 | mg/kg | 6.29E-01 | 6.81E-04 | 1.52E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 3.40E-03 | 7.6E-03 |
| | | Chromium | 8.55E-01 | mg/kg | 1.27E-01 | mg/kg | 1.27E-01 | 1.37E-04 | 3.08E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 9.17E-05 | 2.1E-04 |
| | | Cobalt | 3.35E-01 | mg/kg | 1.81E-01 | mg/kg | 1.81E-01 | 1.96E-04 | 4.39E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.53E-01 | **1.5E+00** |
| | | Iron | 2.96E+01 | mg/kg | 1.60E+01 | mg/kg | 1.60E+01 | 1.73E-02 | 3.87E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.47E-02 | 5.5E-02 |
| | | Manganese | 7.15E+02 | mg/kg | 7.72E+00 | mg/kg | 7.72E+00 | 8.36E-03 | 1.87E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 5.97E-02 | 1.3E-01 |
| | | Mercury | 2.10E-01 | mg/kg | 1.42E+00 | mg/kg | 1.42E+00 | 1.53E-03 | 3.44E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **5.12E+00** | **1.1E+01** |
| | | Thallium | 1.62E-02 | mg/kg | 1.75E-02 | mg/kg | 1.75E-02 | 1.89E-05 | 4.24E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | **1.89E+00** | **4.2E+00** |
| | | Vanadium | 6.45E-02 | mg/kg | 4.35E-03 | mg/kg | 4.35E-03 | 4.71E-06 | 1.06E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 9.43E-04 | 2.1E-03 |
| | | | | | | | | | | | | **Hazard Index** | **8.06E+00** | **1.80E+01** |
| Birds | Ingestion | Aluminum | 1.59E+01 | mg/kg | 1.59E+01 | mg/kg | 1.59E+01 | 8.39E-03 | 1.88E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 8.39E-03 | 1.9E-02 |
| | | Antimony | 2.72E+00 | mg/kg | 2.72E+00 | mg/kg | 2.72E+00 | 1.44E-03 | 3.23E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **3.60E+00** | **8.1E+00** |
| | | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 2.81E-04 | 6.30E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.37E-01 | **2.1E+00** |
| | | Arsenic (inorganic) | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 1.55E+02 | mg/kg | 1.55E+02 | mg/kg | 1.55E+02 | 8.20E-02 | 1.84E-01 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.10E-01 | 9.2E-01 |
| | | Chromium | 8.55E-01 | mg/kg | 8.55E-01 | mg/kg | 8.55E-01 | 4.52E-04 | 1.01E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | 3.01E-04 | 6.7E-04 |
| | | Cobalt | 3.35E-01 | mg/kg | 3.35E-01 | mg/kg | 3.35E-01 | 1.77E-04 | 3.97E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.90E-01 | **1.3E+00** |
| | | Iron | 2.96E+01 | mg/kg | 2.96E+01 | mg/kg | 2.96E+01 | 1.56E-02 | 3.50E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.23E-02 | 5.0E-02 |
| | | Manganese | 7.15E+02 | mg/kg | 7.15E+02 | mg/kg | 7.15E+02 | 3.78E-01 | 8.46E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | **2.70E+00** | **6.0E+00** |
| | | Mercury | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 1.11E-04 | 2.49E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.70E-01 | 8.3E-01 |
| | | Thallium | 1.62E-02 | mg/kg | 1.62E-02 | mg/kg | 1.62E-02 | 8.56E-06 | 1.92E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | 8.56E-01 | **1.9E+00** |
| | | Vanadium | 6.45E-02 | mg/kg | 6.45E-02 | mg/kg | 6.45E-02 | 3.41E-05 | 7.64E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.82E-03 | 1.5E-02 |
| | | | | | | | | | | | | **Hazard Index** | **9.50E+00** | **2.13E+01** |
| Berries and Plants | Ingestion | Aluminum | 1.30E+02 | mg/kg | 1.30E+02 | mg/kg | 1.30E+02 | 2.01E-02 | 4.50E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 2.01E-02 | 4.5E-02 |
| | | Antimony | 1.03E+01 | mg/kg | 1.03E+01 | mg/kg | 1.03E+01 | 1.60E-03 | 3.59E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **4.01E+00** | **9.0E+00** |
| | | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 1.18E-03 | 2.64E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.92E+00** | **8.8E+00** |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 5.99E+01 | mg/kg | 5.99E+01 | mg/kg | 5.99E+01 | 9.30E-03 | 2.08E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.65E-02 | 1.0E-01 |
| | | Chromium | 8.35E-01 | mg/kg | 8.35E-01 | mg/kg | 8.35E-01 | 1.30E-04 | 2.90E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 8.64E-05 | 1.9E-04 |
| | | Cobalt | 2.33E-01 | mg/kg | 2.33E-01 | mg/kg | 2.33E-01 | 3.62E-05 | 8.10E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.21E-01 | 2.7E-01 |
| | | Iron | 1.97E+02 | mg/kg | 1.97E+02 | mg/kg | 1.97E+02 | 3.06E-02 | 6.86E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 4.37E-02 | 9.8E-02 |
| | | Manganese | 1.90E+03 | mg/kg | 1.90E+03 | mg/kg | 1.90E+03 | 2.96E-01 | 6.62E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | **2.11E+00** | **4.7E+00** |
| | | Mercury | 5.64E+00 | mg/kg | 5.64E+00 | mg/kg | 5.64E+00 | 8.76E-04 | 1.96E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.92E+00** | **6.5E+00** |
| | | Thallium | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 3.26E-05 | 7.30E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | **3.26E+00** | **7.3E+00** |
| | | Vanadium | 9.17E-01 | mg/kg | 9.17E-01 | mg/kg | 9.17E-01 | 1.42E-04 | 3.19E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.85E-02 | 6.4E-02 |
| | | | | | | | | | | | | **Hazard Index** | **1.65E+01** | **3.69E+01** |

## Table D-7
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - MPA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Berries and Plants | Ingestion | Aluminum | 9.36E+03 | mg/kg | 6.09E+00 | mg/kg | 6.09E+00 | 1.24E-03 | 2.79E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.24E-03 | 2.8E-03 |
| | | Antimony | 4.52E+03 | mg/kg | 1.35E+02 | mg/kg | 1.35E+02 | 2.77E-02 | 6.20E-02 | mg/kg-d | 4.0E-04 | mg/kg-d | **6.92E+01** | **1.5E+02** |
| | | Arsenic | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 7.80E+03 | mg/kg | 4.68E+01 | mg/kg | 4.68E+01 | 9.57E-03 | 2.14E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.19E+01** | **7.1E+01** |
| | | Barium | 3.79E+02 | mg/kg | 5.69E+00 | mg/kg | 5.69E+00 | 1.16E-03 | 2.60E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 5.81E-03 | 1.3E-02 |
| | | Chromium | 2.41E+01 | mg/kg | 1.08E-01 | mg/kg | 1.08E-01 | 2.21E-05 | 4.95E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.47E-05 | 3.3E-05 |
| | | Cobalt | 1.61E+01 | mg/kg | 1.13E-01 | mg/kg | 1.13E-01 | 2.31E-05 | 5.17E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 7.69E-02 | 1.7E-01 |
| | | Iron | 3.71E+04 | mg/kg | 3.71E+01 | mg/kg | 3.71E+01 | 7.58E-03 | 1.70E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.08E-02 | 2.4E-02 |
| | | Manganese | 7.28E+02 | mg/kg | 3.64E+01 | mg/kg | 3.64E+01 | 7.43E-03 | 1.67E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 5.31E-02 | 1.2E-01 |
| | | Mercury | 5.06E+02 | mg/kg | 1.01E+02 | mg/kg | 1.01E+02 | 2.07E-02 | 4.63E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **6.89E+01** | **1.5E+02** |
| | | Thallium | 1.74E-01 | mg/kg | 6.96E-05 | mg/kg | 6.96E-05 | 1.42E-08 | 3.18E-08 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.42E-03 | 3.2E-03 |
| | | Vanadium | 2.98E+01 | mg/kg | 8.94E-02 | mg/kg | 8.94E-02 | 1.83E-05 | 4.09E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 3.65E-03 | 8.2E-03 |
| | | | | | | | | | | | | **Hazard Index** | **1.70E+02** | **3.81E+02** |

| | | |
|---|---|---|
| **Total Hazard Index** | **1.29E+03** | **3.14E+03** |

## Table D-8
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - DA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Aluminum | 1.17E+04 | mg/kg | 1.17E+04 | mg/kg | 1.17E+04 | 1.23E-02 | 1.15E-01 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.23E-02 | 1.2E-01 |
| | | Antimony | 7.99E+02 | mg/kg | 7.99E+02 | mg/kg | 7.99E+02 | 8.44E-04 | 7.88E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **2.11E+00** | **2.0E+01** |
| | | Arsenic (inorganic) | 3.41E+03 | mg/kg | 3.41E+03 | mg/kg | 3.41E+03 | 2.16E-03 | 2.02E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **7.20E+00** | **6.7E+01** |
| | | Barium | 2.03E+02 | mg/kg | 2.03E+02 | mg/kg | 2.03E+02 | 2.14E-04 | 2.00E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.07E-03 | 1.0E-02 |
| | | Chromium | 2.43E+01 | mg/kg | 2.43E+01 | mg/kg | 2.43E+01 | 2.57E-05 | 2.40E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.71E-05 | 1.6E-04 |
| | | Cobalt | 1.28E+01 | mg/kg | 1.28E+01 | mg/kg | 1.28E+01 | 1.35E-05 | 1.26E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 4.49E-02 | 4.2E-01 |
| | | Iron | 3.48E+04 | mg/kg | 3.48E+04 | mg/kg | 3.48E+04 | 3.67E-02 | 3.43E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 5.25E-02 | 4.9E-01 |
| | | Manganese | 4.71E+02 | mg/kg | 4.71E+02 | mg/kg | 4.71E+02 | 4.98E-04 | 4.65E-03 | mg/kg-d | 2.4E-02 | mg/kg-d | 2.07E-02 | 1.9E-01 |
| | | Mercury | 1.63E+02 | mg/kg | 1.63E+02 | mg/kg | 1.63E+02 | 1.72E-04 | 1.60E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.72E-01 | **5.3E+00** |
| | | Thallium | 1.95E-01 | mg/kg | 1.95E-01 | mg/kg | 1.95E-01 | 2.06E-07 | 1.92E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | 2.06E-02 | 1.9E-01 |
| | | Vanadium | 3.55E+01 | mg/kg | 3.55E+01 | mg/kg | 3.55E+01 | 3.75E-05 | 3.50E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 7.50E-03 | 7.0E-02 |
| | | | | | | | | | | | | **Hazard Index** | **1.00E+01** | **9.37E+01** |
| Soil | Dermal | Aluminum | 1.17E+04 | mg/kg | 1.17E+04 | mg/kg | 1.17E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Antimony | 7.99E+02 | mg/kg | 7.99E+02 | mg/kg | 7.99E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 3.41E+03 | mg/kg | 3.41E+03 | mg/kg | 3.41E+03 | 4.31E-04 | 2.82E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.44E+00** | **9.4E+00** |
| | | Barium | 2.03E+02 | mg/kg | 2.03E+02 | mg/kg | 2.03E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Chromium | 2.43E+01 | mg/kg | 2.43E+01 | mg/kg | 2.43E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.28E+01 | mg/kg | 1.28E+01 | mg/kg | 1.28E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Iron | 3.48E+04 | mg/kg | 3.48E+04 | mg/kg | 3.48E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Manganese | 4.71E+02 | mg/kg | 4.71E+02 | mg/kg | 4.71E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Mercury | 1.63E+02 | mg/kg | 1.63E+02 | mg/kg | 1.63E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | 1.95E-01 | mg/kg | 1.95E-01 | mg/kg | 1.95E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 3.55E+01 | mg/kg | 3.55E+01 | mg/kg | 3.55E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **1.44E+00** | **9.40E+00** |
| Sediment | Dermal | Aluminum | 1.08E+04 | mg/kg | 1.08E+04 | mg/kg | 1.08E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Antimony | 4.46E+03 | mg/kg | 4.46E+03 | mg/kg | 4.46E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.53E-03 | 1.66E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **8.43E+00** | **5.5E+01** |
| | | Barium | 6.81E+02 | mg/kg | 6.81E+02 | mg/kg | 6.81E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cadmium | 2.92E-01 | mg/kg | 2.92E-01 | mg/kg | 2.92E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.5E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Chromium | 2.57E+01 | mg/kg | 2.57E+01 | mg/kg | 2.57E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Copper | 3.72E+01 | mg/kg | 3.72E+01 | mg/kg | 3.72E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 4.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Iron | 9.92E+04 | mg/kg | 9.92E+04 | mg/kg | 9.92E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Manganese | 2.02E+03 | mg/kg | 2.02E+03 | mg/kg | 2.02E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Mercury | 6.66E+01 | mg/kg | 6.66E+01 | mg/kg | 6.66E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Methyl Mercury | 5.23E-03 | mg/kg | 5.23E-03 | mg/kg | 5.23E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Nickel | 5.70E+01 | mg/kg | 5.70E+01 | mg/kg | 5.70E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 8.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Selenium | 4.87E-01 | mg/kg | 4.87E-01 | mg/kg | 4.87E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Silver | 1.14E-01 | mg/kg | 1.14E-01 | mg/kg | 1.14E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | 1.49E-01 | mg/kg | 1.49E-01 | mg/kg | 1.49E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 3.10E+01 | mg/kg | 3.10E+01 | mg/kg | 3.10E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Zinc | 9.16E+01 | mg/kg | 9.16E+01 | mg/kg | 9.16E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **8.43E+00** | **5.52E+01** |

# Table D-8
# CALCULATION OF NON-CANCER HAZARDS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - DA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | Ingestion | Antimony | 5.61E+03 | ug/L | 5.61E+03 | ug/L | 5.61E+03 | 1.54E-01 | 3.59E-01 | mg/kg-d | 4.0E-04 | mg/kg-d | **3.84E+02** | **9.0E+02** |
| | | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+03 | ug/L | 1.80E+03 | 4.94E-02 | 1.15E-01 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.65E+02** | **3.8E+02** |
| | | Barium | 1.01E+02 | ug/L | 1.01E+02 | ug/L | 1.01E+02 | 2.76E-03 | 6.43E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.38E-02 | 3.2E-02 |
| | | Chromium | 3.51E+00 | ug/L | 3.51E+00 | ug/L | 3.51E+00 | 9.61E-05 | 2.24E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 6.40E-05 | 1.5E-04 |
| | | Cobalt | 9.79E+00 | ug/L | 9.79E+00 | ug/L | 9.79E+00 | 2.68E-04 | 6.26E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.94E-01 | **2.1E+00** |
| | | Iron | 8.04E+03 | ug/L | 8.04E+03 | ug/L | 8.04E+03 | 2.20E-01 | 5.14E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 3.15E-01 | 7.3E-01 |
| | | Manganese | 2.24E+03 | ug/L | 2.24E+03 | ug/L | 2.24E+03 | 6.15E-02 | 1.43E-01 | mg/kg-d | 2.4E-02 | mg/kg-d | **2.56E+00** | **6.0E+00** |
| | | Mercury | 1.48E+01 | ug/L | 1.48E+01 | ug/L | 1.48E+01 | 4.05E-04 | 9.45E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.35E+00** | **3.2E+00** |
| | | Nickel | 1.73E+01 | ug/L | 1.73E+01 | ug/L | 1.73E+01 | 4.74E-04 | 1.11E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.37E-02 | 5.5E-02 |
| | | Selenium | 9.17E-01 | ug/L | 9.17E-01 | ug/L | 9.17E-01 | 2.51E-05 | 5.86E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 5.02E-03 | 1.2E-02 |
| | | Thallium | 1.71E-02 | ug/L | 1.71E-02 | ug/L | 1.71E-02 | 4.68E-07 | 1.09E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | 4.68E-02 | 1.1E-01 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 1.56E-04 | 3.64E-04 | mg/kg-d | 2.0E-02 | mg/kg-d | 7.81E-03 | 1.8E-02 |
| | | | | | | | | | | | | **Hazard Index** | **5.54E+02** | **1.29E+03** |
| Groundwater | Dermal | Antimony | 5.61E+03 | ug/L | 5.61E+00 | mg/L | 5.61E+00 | 3.46E-04 | 7.81E-07 | mg/kg-d | 6.0E-05 | mg/kg-d | **5.76E+00** | 1.3E-02 |
| | | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+00 | mg/L | 1.80E+00 | 1.11E-04 | 2.51E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.70E-01 | 8.4E-01 |
| | | Barium | 1.01E+02 | ug/L | 1.01E-01 | mg/L | 1.01E-01 | 6.20E-06 | 1.40E-05 | mg/kg-d | 1.4E-02 | mg/kg-d | 4.43E-04 | 1.0E-03 |
| | | Chromium | 3.51E+00 | ug/L | 3.51E-03 | mg/L | 3.51E-03 | 2.16E-07 | 4.88E-07 | mg/kg-d | 2.0E-02 | mg/kg-d | 1.08E-05 | 2.4E-05 |
| | | Cobalt | 9.79E+00 | ug/L | 9.79E-03 | mg/L | 9.79E-03 | 2.41E-07 | 5.45E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.04E-04 | 1.8E-03 |
| | | Iron | 8.04E+03 | ug/L | 8.04E+00 | mg/L | 8.04E+00 | 4.96E-04 | 1.12E-03 | mg/kg-d | 7.0E-01 | mg/kg-d | 7.08E-04 | 1.6E-03 |
| | | Manganese | 2.24E+03 | ug/L | 2.24E+00 | mg/L | 2.24E+00 | 1.38E-04 | 3.12E-04 | mg/kg-d | 9.6E-04 | mg/kg-d | 1.44E-01 | 3.3E-01 |
| | | Mercury | 1.48E+01 | ug/L | 1.48E-02 | mg/L | 1.48E-02 | 9.12E-07 | 2.06E-06 | mg/kg-d | 2.1E-05 | mg/kg-d | 4.34E-02 | 9.8E-02 |
| | | Nickel | 1.73E+01 | ug/L | 1.73E-02 | mg/L | 1.73E-02 | 2.13E-07 | 4.81E-07 | mg/kg-d | 8.0E-04 | mg/kg-d | 2.66E-04 | 6.0E-04 |
| | | Selenium | 9.17E-01 | ug/L | 9.17E-04 | mg/L | 9.17E-04 | 5.65E-08 | 1.28E-07 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.13E-05 | 2.6E-05 |
| | | Thallium | 1.71E-02 | ug/L | 1.71E-05 | mg/L | 1.71E-05 | 1.05E-09 | 2.38E-09 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.05E-04 | 2.4E-04 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **6.32E+00** | **1.28E+00** |
| Surface Water | Dermal | Antimony | 1.36E+02 | ug/L | 1.36E-01 | mg/L | 1.36E-01 | 1.80E-06 | 6.16E-06 | mg/kg-d | 6.0E-05 | mg/kg-d | 3.01E-02 | 1.0E-01 |
| | | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 7.63E-06 | 2.60E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.54E-02 | 8.7E-02 |
| | | Cadmium | 6.00E-03 | ug/L | 6.00E-06 | mg/L | 6.00E-06 | 7.99E-11 | 2.73E-10 | mg/kg-d | 2.5E-05 | mg/kg-d | 3.20E-06 | 1.1E-05 |
| | | Cobalt | 3.04E+00 | ug/L | 3.04E-03 | mg/L | 3.04E-03 | 1.62E-08 | 5.53E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.40E-05 | 1.8E-04 |
| | | Copper | 4.31E-01 | ug/L | 4.31E-04 | mg/L | 4.31E-04 | 5.74E-09 | 1.96E-08 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.44E-07 | 4.9E-07 |
| | | Iron | 1.33E+03 | ug/L | 1.33E+00 | mg/L | 1.33E+00 | 1.76E-05 | 6.03E-05 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.52E-05 | 8.6E-05 |
| | | Manganese | 1.71E+02 | ug/L | 1.71E-01 | mg/L | 1.71E-01 | 2.27E-06 | 7.76E-06 | mg/kg-d | 9.6E-04 | mg/kg-d | 2.37E-03 | 8.1E-03 |
| | | Mercury | 2.41E-01 | ug/L | 2.41E-04 | mg/L | 2.41E-04 | 3.21E-09 | 1.10E-08 | mg/kg-d | 2.1E-05 | mg/kg-d | 1.53E-04 | 5.2E-04 |
| | | Methyl Mercury | 3.13E-04 | ug/L | 3.13E-07 | mg/L | 3.13E-07 | 4.17E-12 | 1.42E-11 | mg/kg-d | 1.0E-04 | mg/kg-d | 4.17E-08 | 1.4E-07 |
| | | Nickel | 1.05E+01 | ug/L | 1.05E-02 | mg/L | 1.05E-02 | 2.81E-08 | 9.59E-08 | mg/kg-d | 8.0E-04 | mg/kg-d | 3.51E-05 | 1.2E-04 |
| | | Selenium | 3.85E-01 | ug/L | 3.85E-04 | mg/L | 3.85E-04 | 5.13E-09 | 1.75E-08 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.03E-06 | 3.5E-06 |
| | | Silver | 2.60E-02 | ug/L | 2.60E-05 | mg/L | 2.60E-05 | 2.08E-10 | 7.09E-10 | mg/kg-d | 2.0E-04 | mg/kg-d | 1.04E-06 | 3.5E-06 |
| | | Zinc | 7.27E-01 | ug/L | 7.27E-04 | mg/L | 7.27E-04 | 5.81E-09 | 1.98E-08 | mg/kg-d | 3.0E-01 | mg/kg-d | 1.94E-08 | 6.6E-08 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Naphthalene | 6.80E-01 | ug/L | 6.80E-04 | mg/L | 6.80E-04 | 4.26E-07 | 1.45E-06 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.13E-05 | 7.3E-05 |
| | | | | | | | | | | | | **Hazard Index** | 5.82E-02 | 1.99E-01 |
| Air | Dust Particulates or Volatile from Soil | Aluminum | 1.17E+04 | mg/kg | 1.72E-05 | mg/m3 | 1.72E-05 | 1.27E-05 | 1.27E-05 | mg/m3 | 5.0E-03 | mg/m3 | 2.54E-03 | 2.5E-03 |
| | | Antimony | 7.99E+02 | mg/kg | 1.17E-06 | mg/m3 | 1.17E-06 | 8.69E-07 | 8.69E-07 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Arsenic (inorganic) | 3.41E+03 | mg/kg | 5.01E-06 | mg/m3 | 5.01E-06 | 2.22E-06 | 2.22E-06 | mg/m3 | 1.5E-05 | mg/m3 | 1.48E-01 | 1.5E-01 |
| | | Barium | 2.03E+02 | mg/kg | 2.98E-07 | mg/m3 | 2.98E-07 | 2.21E-07 | 2.21E-07 | mg/m3 | 5.0E-04 | mg/m3 | 4.41E-04 | 4.4E-04 |
| | | Chromium | 2.43E+01 | mg/kg | 3.57E-08 | mg/m3 | 3.57E-08 | 2.64E-08 | 2.64E-08 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Cobalt | 1.28E+01 | mg/kg | 1.88E-08 | mg/m3 | 1.88E-08 | 1.39E-08 | 1.39E-08 | mg/m3 | 6.0E-06 | mg/m3 | 2.31E-03 | 2.3E-03 |
| | | Iron | 3.48E+04 | mg/kg | 5.11E-05 | mg/m3 | 5.11E-05 | 3.78E-05 | 3.78E-05 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Manganese | 4.71E+02 | mg/kg | 6.93E-07 | mg/m3 | 6.93E-07 | 5.12E-07 | 5.12E-07 | mg/m3 | 5.0E-05 | mg/m3 | 1.02E-02 | 1.0E-02 |
| | | Mercury | 1.63E+02 | mg/kg | 7.29E-03 | mg/m3 | 7.29E-03 | 5.39E-03 | 5.39E-03 | mg/m3 | 3.0E-04 | mg/m3 | **1.80E+01** | **1.8E+01** |
| | | Thallium | 1.95E-01 | mg/kg | 2.87E-10 | mg/m3 | 2.87E-10 | 2.12E-10 | 2.12E-10 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Vanadium | 3.55E+01 | mg/kg | 5.22E-08 | mg/m3 | 5.22E-08 | 3.86E-08 | 3.86E-08 | mg/m3 | -- | mg/m3 | -- | -- |
| | | | | | | | | | | | | **Hazard Index** | **1.81E+01** | **1.81E+01** |

# Table D-8
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - DA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Air | Volatile from Groundwater | Mercury | 1.48E+01 | ug/L | 7.39E-03 | mg/m3 | 7.39E-03 | 2.22E-04 | 2.22E-04 | mg/m3 | 3.0E-04 | mg/m3 | 7.39E-01 | 7.4E-01 |
| Non-Salmon Fish | Ingestion | Aluminum | 3.22E+01 | mg/kg | 3.22E+01 | mg/kg | 3.22E+01 | 1.25E-01 | 2.80E-01 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.25E-01 | 2.8E-01 |
| | | Antimony | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 6.60E-02 | 1.48E-01 | mg/kg-d | 4.0E-04 | mg/kg-d | **1.65E+02** | **3.7E+02** |
| | | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 4.41E-03 | 9.89E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.47E+01** | **3.3E+01** |
| | | Barium | 3.79E+00 | mg/kg | 3.79E+00 | mg/kg | 3.79E+00 | 1.47E-02 | 3.28E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 7.33E-02 | 1.6E-01 |
| | | Cadmium | 4.42E-02 | mg/kg | 4.42E-02 | mg/kg | 4.42E-02 | 1.71E-04 | 3.83E-04 | mg/kg-d | 1.0E-03 | mg/kg-d | 1.71E-01 | 3.8E-01 |
| | | Chromium | 6.80E-01 | mg/kg | 6.80E-01 | mg/kg | 6.80E-01 | 2.63E-03 | 5.90E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.76E-03 | 3.9E-03 |
| | | Cobalt | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Copper | 1.25E+00 | mg/kg | 1.25E+00 | mg/kg | 1.25E+00 | 4.85E-03 | 1.09E-02 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.21E-01 | 2.7E-01 |
| | | Iron | 8.89E+01 | mg/kg | 8.89E+01 | mg/kg | 8.89E+01 | 3.44E-01 | 7.71E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 4.92E-01 | **1.1E+00** |
| | | Manganese | 1.25E+01 | mg/kg | 1.25E+01 | mg/kg | 1.25E+01 | 4.84E-02 | 1.08E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | 3.46E-01 | 7.7E-01 |
| | | Mercury | 2.14E+00 | mg/kg | 6.42E+00 | mg/kg | 6.42E+00 | 2.49E-02 | 5.57E-02 | mg/kg-d | 1.0E-04 | mg/kg-d | **2.49E+02** | **5.6E+02** |
| | | Nickel | 1.47E-01 | mg/kg | 1.47E-01 | mg/kg | 1.47E-01 | 5.69E-04 | 1.27E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 2.85E-02 | 6.4E-02 |
| | | Selenium | 1.89E+00 | mg/kg | 1.89E+00 | mg/kg | 1.89E+00 | 7.32E-03 | 1.64E-02 | mg/kg-d | 5.0E-03 | mg/kg-d | **1.46E+00** | **3.3E+00** |
| | | Silver | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 2.21E-01 | mg/kg | 2.21E-01 | mg/kg | 2.21E-01 | 8.56E-04 | 1.92E-03 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.71E-01 | 3.8E-01 |
| | | Zinc | 2.66E+01 | mg/kg | 2.66E+01 | mg/kg | 2.66E+01 | 1.03E-01 | 2.30E-01 | mg/kg-d | 3.0E-01 | mg/kg-d | 3.43E-01 | 7.7E-01 |
| | | | | | | | | | | | | **Hazard Index** | **4.32E+02** | **9.67E+02** |
| Large Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 6.43E-01 | mg/kg | 6.43E-01 | 6.96E-04 | 1.56E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 6.96E-04 | 1.6E-03 |
| | | Antimony | 2.72E+00 | mg/kg | 7.35E-02 | mg/kg | 7.35E-02 | 7.96E-05 | 1.78E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 1.99E-01 | 4.5E-01 |
| | | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 3.11E-05 | 6.97E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.04E-01 | 2.3E-01 |
| | | Barium | 1.55E+02 | mg/kg | 6.29E-01 | mg/kg | 6.29E-01 | 6.81E-04 | 1.52E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 3.40E-03 | 7.6E-03 |
| | | Chromium | 8.55E-01 | mg/kg | 1.27E-01 | mg/kg | 1.27E-01 | 1.37E-04 | 3.08E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 9.17E-05 | 2.1E-04 |
| | | Cobalt | 3.35E-01 | mg/kg | 1.81E-01 | mg/kg | 1.81E-01 | 1.96E-04 | 4.39E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.53E-01 | **1.5E+00** |
| | | Iron | 2.96E+01 | mg/kg | 1.60E+01 | mg/kg | 1.60E+01 | 1.73E-02 | 3.87E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.47E-02 | 5.5E-02 |
| | | Manganese | 7.15E+02 | mg/kg | 7.72E+00 | mg/kg | 7.72E+00 | 8.36E-03 | 1.87E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 5.97E-02 | 1.3E-01 |
| | | Mercury | 2.10E-01 | mg/kg | 1.42E+00 | mg/kg | 1.42E+00 | 1.53E-03 | 3.44E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **5.12E+00** | **1.1E+01** |
| | | Thallium | 1.62E-02 | mg/kg | 1.75E-02 | mg/kg | 1.75E-02 | 1.89E-05 | 4.24E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | **1.89E+00** | **4.2E+00** |
| | | Vanadium | 6.45E-02 | mg/kg | 4.35E-03 | mg/kg | 4.35E-03 | 4.71E-06 | 1.06E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 9.43E-04 | 2.1E-03 |
| | | | | | | | | | | | | **Hazard Index** | **8.06E+00** | **1.80E+01** |
| Small Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 1.59E+01 | mg/kg | 1.59E+01 | 8.39E-03 | 1.88E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 8.39E-03 | 1.9E-02 |
| | | Antimony | 2.72E+00 | mg/kg | 2.72E+00 | mg/kg | 2.72E+00 | 1.44E-03 | 3.23E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **3.60E+00** | **8.1E+00** |
| | | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 2.81E-04 | 6.30E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.37E-01 | **2.1E+00** |
| | | Barium | 1.55E+02 | mg/kg | 1.55E+02 | mg/kg | 1.55E+02 | 8.20E-02 | 1.84E-01 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.10E-01 | 9.2E-01 |
| | | Chromium | 8.55E-01 | mg/kg | 8.55E-01 | mg/kg | 8.55E-01 | 4.52E-04 | 1.01E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | 3.01E-04 | 6.7E-04 |
| | | Cobalt | 3.35E-01 | mg/kg | 3.35E-01 | mg/kg | 3.35E-01 | 1.77E-04 | 3.97E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.90E-01 | **1.3E+00** |
| | | Iron | 2.96E+01 | mg/kg | 2.96E+01 | mg/kg | 2.96E+01 | 1.56E-02 | 3.50E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.23E-02 | 5.0E-02 |
| | | Manganese | 7.15E+02 | mg/kg | 7.15E+02 | mg/kg | 7.15E+02 | 3.78E-01 | 8.46E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | **2.70E+00** | **6.0E+00** |
| | | Mercury | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 1.11E-04 | 2.49E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.70E-01 | 8.3E-01 |
| | | Thallium | 1.62E-02 | mg/kg | 1.62E-02 | mg/kg | 1.62E-02 | 8.56E-06 | 1.92E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | 8.56E-01 | **1.9E+00** |
| | | Vanadium | 6.45E-02 | mg/kg | 6.45E-02 | mg/kg | 6.45E-02 | 3.41E-05 | 7.64E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.82E-03 | 1.5E-02 |
| | | | | | | | | | | | | **Hazard Index** | **9.50E+00** | **2.13E+01** |
| Birds | Ingestion | Aluminum | 1.30E+02 | mg/kg | 1.30E+02 | mg/kg | 1.30E+02 | 2.01E-02 | 4.50E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 2.01E-02 | 4.5E-02 |
| | | Antimony | 1.03E+01 | mg/kg | 1.03E+01 | mg/kg | 1.03E+01 | 1.60E-03 | 3.59E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **4.01E+00** | **9.0E+00** |
| | | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 1.18E-03 | 2.64E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.92E+00** | **8.8E+00** |
| | | Barium | 5.99E+01 | mg/kg | 5.99E+01 | mg/kg | 5.99E+01 | 9.30E-03 | 2.08E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.65E-02 | 1.0E-01 |
| | | Chromium | 8.35E-01 | mg/kg | 8.35E-01 | mg/kg | 8.35E-01 | 1.30E-04 | 2.90E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 8.64E-05 | 1.9E-04 |
| | | Cobalt | 2.33E-01 | mg/kg | 2.33E-01 | mg/kg | 2.33E-01 | 3.62E-05 | 8.10E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.21E-01 | 2.7E-01 |
| | | Iron | 1.97E+02 | mg/kg | 1.97E+02 | mg/kg | 1.97E+02 | 3.06E-02 | 6.86E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 4.37E-02 | 9.8E-02 |
| | | Manganese | 1.90E+03 | mg/kg | 1.90E+03 | mg/kg | 1.90E+03 | 2.96E-01 | 6.62E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | **2.11E+00** | **4.7E+00** |
| | | Mercury | 5.64E+00 | mg/kg | 5.64E+00 | mg/kg | 5.64E+00 | 8.76E-04 | 1.96E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.92E+00** | **6.5E+00** |
| | | Thallium | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 3.26E-05 | 7.30E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | **3.26E+00** | **7.3E+00** |
| | | Vanadium | 9.17E-01 | mg/kg | 9.17E-01 | mg/kg | 9.17E-01 | 1.42E-04 | 3.19E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.85E-02 | 6.4E-02 |
| | | | | | | | | | | | | **Hazard Index** | **1.65E+01** | **3.69E+01** |

## Table D-8
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - DA
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Berries and Plants | Ingestion | Aluminum | 1.17E+04 | mg/kg | 7.59E+00 | mg/kg | 7.59E+00 | 1.55E-03 | 3.47E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.55E-03 | 3.5E-03 |
| | | Antimony | 7.99E+02 | mg/kg | 2.40E+01 | mg/kg | 2.40E+01 | 4.89E-03 | 1.10E-02 | mg/kg-d | 4.0E-04 | mg/kg-d | **1.22E+01** | **2.7E+01** |
| | | Arsenic (inorganic) | 3.41E+03 | mg/kg | 2.04E+01 | mg/kg | 2.04E+01 | 4.17E-03 | 9.35E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.39E+01** | **3.1E+01** |
| | | Barium | 2.03E+02 | mg/kg | 3.04E+00 | mg/kg | 3.04E+00 | 6.21E-04 | 1.39E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 3.11E-03 | 7.0E-03 |
| | | Chromium | 2.43E+01 | mg/kg | 1.09E-01 | mg/kg | 1.09E-01 | 2.23E-05 | 5.00E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.49E-05 | 3.3E-05 |
| | | Cobalt | 1.28E+01 | mg/kg | 8.93E-02 | mg/kg | 8.93E-02 | 1.82E-05 | 4.08E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.08E-02 | 1.4E-01 |
| | | Iron | 3.48E+04 | mg/kg | 3.48E+01 | mg/kg | 3.48E+01 | 7.10E-03 | 1.59E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.01E-02 | 2.3E-02 |
| | | Manganese | 4.71E+02 | mg/kg | 2.36E+01 | mg/kg | 2.36E+01 | 4.81E-03 | 1.08E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 3.44E-02 | 7.7E-02 |
| | | Mercury | 1.63E+02 | mg/kg | 3.25E+01 | mg/kg | 3.25E+01 | 6.64E-03 | 1.49E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.21E+01** | **5.0E+01** |
| | | Thallium | 1.95E-01 | mg/kg | 7.80E-05 | mg/kg | 7.80E-05 | 1.59E-08 | 3.57E-08 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.59E-03 | 3.6E-03 |
| | | Vanadium | 3.55E+01 | mg/kg | 1.06E-01 | mg/kg | 1.06E-01 | 2.17E-05 | 4.87E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 4.35E-03 | 9.7E-03 |
| | | | | | | | | | | | | **Hazard Index** | **4.84E+01** | **1.08E+02** |

| | | |
|---|---|---|
| **Total Hazard Index** | **1.11E+03** | **2.62E+03** |

# Table D-9
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Current/Future
Receptor Population: Recreational/Subsistence User
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Aluminum | 9.28E+03 | mg/kg | 9.28E+03 | mg/kg | 9.28E+03 | 3.27E-03 | 3.05E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 3.27E-03 | 3.1E-02 |
| | | Antimony | 3.78E+03 | mg/kg | 3.78E+03 | mg/kg | 3.78E+03 | 1.33E-03 | 1.24E-02 | mg/kg-d | 4.0E-04 | mg/kg-d | **3.33E+00** | **3.1E+01** |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 1.24E-03 | 1.16E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **4.14E+00** | **3.9E+01** |
| | | Barium | 3.22E+02 | mg/kg | 3.22E+02 | mg/kg | 3.22E+02 | 1.14E-04 | 1.06E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 5.68E-04 | 5.3E-03 |
| | | Chromium | 2.35E+01 | mg/kg | 2.35E+01 | mg/kg | 2.35E+01 | 8.26E-06 | 7.71E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 5.51E-06 | 5.1E-05 |
| | | Cobalt | 1.58E+01 | mg/kg | 1.58E+01 | mg/kg | 1.58E+01 | 5.56E-06 | 5.19E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.85E-02 | 1.7E-01 |
| | | Iron | 3.67E+04 | mg/kg | 3.67E+04 | mg/kg | 3.67E+04 | 1.29E-02 | 1.21E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.84E-02 | 1.7E-01 |
| | | Manganese | 7.14E+02 | mg/kg | 7.14E+02 | mg/kg | 7.14E+02 | 2.51E-04 | 2.35E-03 | mg/kg-d | 2.4E-02 | mg/kg-d | 1.05E-02 | 9.8E-02 |
| | | Mercury | 3.73E+02 | mg/kg | 3.73E+02 | mg/kg | 3.73E+02 | 1.31E-04 | 1.23E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | 4.38E-01 | **4.1E+00** |
| | | Thallium | 1.71E-01 | mg/kg | 1.71E-01 | mg/kg | 1.71E-01 | 6.02E-08 | 5.62E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 6.02E-03 | 5.6E-02 |
| | | Vanadium | 3.11E+01 | mg/kg | 3.11E+01 | mg/kg | 3.11E+01 | 1.10E-05 | 1.02E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.19E-03 | 2.0E-02 |
| | | | | | | | | | | | | **Hazard Index** | **7.97E+00** | **7.44E+01** |
| Soil | Dermal | Aluminum | 9.28E+03 | mg/kg | 9.28E+03 | mg/kg | 9.28E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Antimony | 3.78E+03 | mg/kg | 3.78E+03 | mg/kg | 3.78E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 2.48E-04 | 1.62E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.27E-01 | **5.4E+00** |
| | | Barium | 3.22E+02 | mg/kg | 3.22E+02 | mg/kg | 3.22E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Chromium | 2.35E+01 | mg/kg | 2.35E+01 | mg/kg | 2.35E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.58E+01 | mg/kg | 1.58E+01 | mg/kg | 1.58E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Iron | 3.67E+04 | mg/kg | 3.67E+04 | mg/kg | 3.67E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Manganese | 7.14E+02 | mg/kg | 7.14E+02 | mg/kg | 7.14E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Mercury | 3.73E+02 | mg/kg | 3.73E+02 | mg/kg | 3.73E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | 1.71E-01 | mg/kg | 1.71E-01 | mg/kg | 1.71E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 3.11E+01 | mg/kg | 3.11E+01 | mg/kg | 3.11E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | 8.27E-01 | **5.42E+00** |
| Sediment | Dermal | Aluminum | 1.08E+04 | mg/kg | 1.08E+04 | mg/kg | 1.08E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Antimony | 4.46E+03 | mg/kg | 4.46E+03 | mg/kg | 4.46E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 2.53E-03 | 1.66E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **8.43E+00** | **5.5E+01** |
| | | Barium | 6.81E+02 | mg/kg | 6.81E+02 | mg/kg | 6.81E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cadmium | 2.92E-01 | mg/kg | 2.92E-01 | mg/kg | 2.92E-01 | 4.10E-10 | 2.69E-09 | mg/kg-d | 2.5E-05 | mg/kg-d | 1.64E-05 | 1.1E-04 |
| | | Chromium | 2.57E+01 | mg/kg | 2.57E+01 | mg/kg | 2.57E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Copper | 3.72E+01 | mg/kg | 3.72E+01 | mg/kg | 3.72E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 4.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Iron | 9.92E+04 | mg/kg | 9.92E+04 | mg/kg | 9.92E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Manganese | 2.02E+03 | mg/kg | 2.02E+03 | mg/kg | 2.02E+03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Mercury | 6.66E+01 | mg/kg | 6.66E+01 | mg/kg | 6.66E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Methyl Mercury | 5.23E-03 | mg/kg | 5.23E-03 | mg/kg | 5.23E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Nickel | 5.70E+01 | mg/kg | 5.70E+01 | mg/kg | 5.70E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 8.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Selenium | 4.87E-01 | mg/kg | 4.87E-01 | mg/kg | 4.87E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Silver | 1.14E-01 | mg/kg | 1.14E-01 | mg/kg | 1.14E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | 1.49E-01 | mg/kg | 1.49E-01 | mg/kg | 1.49E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 3.10E+01 | mg/kg | 3.10E+01 | mg/kg | 3.10E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Zinc | 9.16E+01 | mg/kg | 9.16E+01 | mg/kg | 9.16E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-01 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **8.43E+00** | **5.52E+01** |

## Table D-9
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Current/Future
Receptor Population: Recreational/Subsistence User
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface Water | Ingestion | Antimony | 1.36E+02 | ug/L | 1.36E-01 | mg/L | 1.36E-01 | 2.12E-07 | 4.95E-07 | mg/kg-d | 6.0E-05 | mg/kg-d | 3.54E-03 | 8.2E-03 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 8.96E-07 | 2.09E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.99E-03 | 7.0E-03 |
| | | Cadmium | 6.00E-03 | ug/L | 6.00E-06 | mg/L | 6.00E-06 | 9.39E-12 | 2.19E-11 | mg/kg-d | 2.5E-05 | mg/kg-d | 3.76E-07 | 8.8E-07 |
| | | Cobalt | 3.04E+00 | ug/L | 3.04E-03 | mg/L | 3.04E-03 | 4.76E-09 | 1.11E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.59E-05 | 3.7E-05 |
| | | Copper | 4.31E-01 | ug/L | 4.31E-04 | mg/L | 4.31E-04 | 6.75E-10 | 1.57E-09 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.69E-08 | 3.9E-08 |
| | | Iron | 1.33E+03 | ug/L | 1.33E+00 | mg/L | 1.33E+00 | 2.07E-06 | 4.84E-06 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.96E-06 | 6.9E-06 |
| | | Manganese | 1.71E+02 | ug/L | 1.71E-01 | mg/L | 1.71E-01 | 2.67E-07 | 6.23E-07 | mg/kg-d | 9.6E-04 | mg/kg-d | 2.78E-04 | 6.5E-04 |
| | | Mercury | 2.41E-01 | ug/L | 2.41E-04 | mg/L | 2.41E-04 | 3.77E-10 | 8.80E-10 | mg/kg-d | 2.1E-05 | mg/kg-d | 1.80E-05 | 4.2E-05 |
| | | Methyl Mercury | 3.13E-04 | ug/L | 3.13E-07 | mg/L | 3.13E-07 | 4.90E-13 | 1.14E-12 | mg/kg-d | 1.0E-04 | mg/kg-d | 4.90E-09 | 1.1E-08 |
| | | Nickel | 1.05E+01 | ug/L | 1.05E-02 | mg/L | 1.05E-02 | 1.65E-08 | 3.85E-08 | mg/kg-d | 8.0E-04 | mg/kg-d | 2.06E-05 | 4.8E-05 |
| | | Selenium | 3.85E-01 | ug/L | 3.85E-04 | mg/L | 3.85E-04 | 6.03E-10 | 1.41E-09 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.21E-07 | 2.8E-07 |
| | | Silver | 2.60E-02 | ug/L | 2.60E-05 | mg/L | 2.60E-05 | 4.07E-11 | 9.50E-11 | mg/kg-d | 2.0E-04 | mg/kg-d | 2.04E-07 | 4.7E-07 |
| | | Zinc | 7.27E-01 | ug/L | 7.27E-04 | mg/L | 7.27E-04 | 1.14E-09 | 2.66E-09 | mg/kg-d | 3.0E-01 | mg/kg-d | 3.79E-09 | 8.9E-09 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 2.35E-09 | 5.48E-09 | mg/kg-d | 7.0E-02 | mg/kg-d | 3.35E-08 | 7.8E-08 |
| | | Naphthalene | 6.80E-01 | ug/L | 6.80E-04 | mg/L | 6.80E-04 | 1.06E-09 | 2.48E-09 | mg/kg-d | 2.0E-02 | mg/kg-d | 5.32E-08 | 1.2E-07 |
| | | | | | | | | | | | | **Hazard Index** | 3.36E-04 | 7.84E-04 |
| Surface Water | Dermal | Antimony | 1.36E+02 | ug/L | 1.36E-01 | mg/L | 1.36E-01 | 6.02E-07 | 2.05E-06 | mg/kg-d | 6.0E-05 | mg/kg-d | 1.00E-02 | 3.4E-02 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 2.54E-06 | 8.68E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.47E-03 | 2.9E-02 |
| | | Cadmium | 6.00E-03 | ug/L | 6.00E-06 | mg/L | 6.00E-06 | 2.66E-11 | 9.10E-11 | mg/kg-d | 2.5E-05 | mg/kg-d | 1.07E-06 | 3.6E-06 |
| | | Cobalt | 3.04E+00 | ug/L | 3.04E-03 | mg/L | 3.04E-03 | 5.40E-09 | 1.84E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.80E-05 | 6.1E-05 |
| | | Copper | 4.31E-01 | ug/L | 4.31E-04 | mg/L | 4.31E-04 | 1.91E-09 | 6.53E-09 | mg/kg-d | 4.0E-02 | mg/kg-d | 4.78E-08 | 1.6E-07 |
| | | Iron | 1.33E+03 | ug/L | 1.33E+00 | mg/L | 1.33E+00 | 5.88E-06 | 2.01E-05 | mg/kg-d | 7.0E-01 | mg/kg-d | 8.40E-06 | 2.9E-05 |
| | | Manganese | 1.71E+02 | ug/L | 1.71E-01 | mg/L | 1.71E-01 | 7.57E-07 | 2.59E-06 | mg/kg-d | 9.6E-04 | mg/kg-d | 7.89E-04 | 2.7E-03 |
| | | Mercury | 2.41E-01 | ug/L | 2.41E-04 | mg/L | 2.41E-04 | 1.07E-09 | 3.65E-09 | mg/kg-d | 2.1E-05 | mg/kg-d | 5.10E-05 | 1.7E-04 |
| | | Methyl Mercury | 3.13E-04 | ug/L | 3.13E-07 | mg/L | 3.13E-07 | 1.39E-12 | 4.75E-12 | mg/kg-d | 1.0E-04 | mg/kg-d | 1.39E-08 | 4.7E-08 |
| | | Nickel | 1.05E+01 | ug/L | 1.05E-02 | mg/L | 1.05E-02 | 9.36E-09 | 3.20E-08 | mg/kg-d | 8.0E-04 | mg/kg-d | 1.17E-05 | 4.0E-05 |
| | | Selenium | 3.85E-01 | ug/L | 3.85E-04 | mg/L | 3.85E-04 | 1.71E-09 | 5.84E-09 | mg/kg-d | 5.0E-03 | mg/kg-d | 3.42E-07 | 1.2E-06 |
| | | Silver | 2.60E-02 | ug/L | 2.60E-05 | mg/L | 2.60E-05 | 6.93E-11 | 2.36E-10 | mg/kg-d | 2.0E-04 | mg/kg-d | 3.46E-07 | 1.2E-06 |
| | | Zinc | 7.27E-01 | ug/L | 7.27E-04 | mg/L | 7.27E-04 | 1.94E-09 | 6.61E-09 | mg/kg-d | 3.0E-01 | mg/kg-d | 6.46E-09 | 2.2E-08 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Naphthalene | 6.80E-01 | ug/L | 6.80E-04 | mg/L | 6.80E-04 | 1.42E-07 | 4.85E-07 | mg/kg-d | 2.0E-02 | mg/kg-d | 7.09E-06 | 2.4E-05 |
| | | | | | | | | | | | | **Hazard Index** | 1.94E-02 | 6.62E-02 |
| Air | Dust Particulates or Volatile from Soil | Aluminum | 9.28E+03 | mg/kg | 2.95E-06 | mg/m3 | 2.95E-06 | 7.29E-07 | 7.29E-07 | mg/m3 | 5.0E-03 | mg/m3 | 1.46E-04 | 1.5E-04 |
| | | Antimony | 3.78E+03 | mg/kg | 1.21E-06 | mg/m3 | 1.21E-06 | 2.97E-07 | 2.97E-07 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/m3 | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/m3 | 1.5E-05 | mg/m3 | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 1.87E-06 | mg/m3 | 1.87E-06 | 2.77E-07 | 2.77E-07 | mg/m3 | 1.5E-05 | mg/m3 | 1.85E-02 | 1.8E-02 |
| | | Barium | 3.22E+02 | mg/kg | 1.03E-07 | mg/m3 | 1.03E-07 | 2.53E-08 | 2.53E-08 | mg/m3 | 5.0E-04 | mg/m3 | 5.06E-05 | 5.1E-05 |
| | | Chromium | 2.35E+01 | mg/kg | 7.47E-09 | mg/m3 | 7.47E-09 | 1.84E-09 | 1.84E-09 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Cobalt | 1.58E+01 | mg/kg | 5.03E-09 | mg/m3 | 5.03E-09 | 1.24E-09 | 1.24E-09 | mg/m3 | 6.0E-06 | mg/m3 | 2.07E-04 | 2.1E-04 |
| | | Iron | 3.67E+04 | mg/kg | 1.17E-05 | mg/m3 | 1.17E-05 | 2.88E-06 | 2.88E-06 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Manganese | 7.14E+02 | mg/kg | 2.27E-07 | mg/m3 | 2.27E-07 | 5.60E-08 | 5.60E-08 | mg/m3 | 5.0E-05 | mg/m3 | 1.12E-03 | 1.1E-03 |
| | | Mercury | 3.73E+02 | mg/kg | 1.67E-02 | mg/m3 | 1.67E-02 | 4.12E-03 | 4.12E-03 | mg/m3 | 3.0E-04 | mg/m3 | **1.37E+01** | **1.4E+01** |
| | | Thallium | 1.71E-01 | mg/kg | 5.45E-11 | mg/m3 | 5.45E-11 | 1.34E-11 | 1.34E-11 | mg/m3 | -- | mg/m3 | -- | -- |
| | | Vanadium | 3.11E+01 | mg/kg | 9.90E-09 | mg/m3 | 9.90E-09 | 2.44E-09 | 2.44E-09 | mg/m3 | -- | mg/m3 | -- | -- |
| | | | | | | | | | | | | **Hazard Index** | **1.38E+01** | **1.38E+01** |

## Table D-9
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Current/Future
Receptor Population: Recreational/Subsistence User
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Aluminum | 3.22E+01 | mg/kg | 3.22E+01 | mg/kg | 3.22E+01 | 2.50E-02 | 5.59E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 2.50E-02 | 5.6E-02 |
| | | Antimony | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 1.32E-02 | 2.96E-02 | mg/kg-d | 4.0E-04 | mg/kg-d | **3.30E+01** | **7.4E+01** |
| | | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 8.83E-04 | 1.98E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.94E+00** | **6.6E+00** |
| | | Arsenic (Inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 3.79E+00 | mg/kg | 3.79E+00 | mg/kg | 3.79E+00 | 2.93E-03 | 6.57E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.47E-02 | 3.3E-02 |
| | | Cadmium | 4.42E-02 | mg/kg | 4.42E-02 | mg/kg | 4.42E-02 | 3.42E-05 | 7.67E-05 | mg/kg-d | 1.0E-03 | mg/kg-d | 3.42E-02 | 7.7E-02 |
| | | Chromium | 6.80E-01 | mg/kg | 6.80E-01 | mg/kg | 6.80E-01 | 5.27E-04 | 1.18E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | 3.51E-04 | 7.9E-04 |
| | | Cobalt | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Copper | 1.25E+00 | mg/kg | 1.25E+00 | mg/kg | 1.25E+00 | 9.69E-04 | 2.17E-03 | mg/kg-d | 4.0E-02 | mg/kg-d | 2.42E-02 | 5.4E-02 |
| | | Iron | 8.89E+01 | mg/kg | 8.89E+01 | mg/kg | 8.89E+01 | 6.88E-02 | 1.54E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 9.83E-02 | 2.2E-01 |
| | | Manganese | 1.25E+01 | mg/kg | 1.25E+01 | mg/kg | 1.25E+01 | 9.68E-03 | 2.17E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 6.91E-02 | 1.5E-01 |
| | | Mercury | 2.14E+00 | mg/kg | 6.42E+00 | mg/kg | 6.42E+00 | 4.97E-03 | 1.11E-02 | mg/kg-d | 1.0E-04 | mg/kg-d | **4.97E+01** | **1.1E+02** |
| | | Methyl Mercury | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | | mg/kg-d | | |
| | | Nickel | 1.47E-01 | mg/kg | 1.47E-01 | mg/kg | 1.47E-01 | 1.14E-04 | 2.55E-04 | mg/kg-d | 2.0E-02 | mg/kg-d | 5.69E-03 | 1.3E-02 |
| | | Selenium | 1.89E+00 | mg/kg | 1.89E+00 | mg/kg | 1.89E+00 | 1.46E-03 | 3.28E-03 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.93E-01 | 6.6E-01 |
| | | Silver | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Thallium | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 2.21E-01 | mg/kg | 2.21E-01 | mg/kg | 2.21E-01 | 1.71E-04 | 3.83E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 3.42E-02 | 7.7E-02 |
| | | Zinc | 2.66E+01 | mg/kg | 2.66E+01 | mg/kg | 2.66E+01 | 2.06E-02 | 4.61E-02 | mg/kg-d | 3.0E-01 | mg/kg-d | 6.86E-02 | 1.5E-01 |
| | | | | | | | | | | | | **Hazard Index** | **8.63E+01** | **1.93E+02** |
| Large Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 6.43E-01 | mg/kg | 6.43E-01 | 9.74E-06 | 2.18E-05 | mg/kg-d | 1.0E+00 | mg/kg-d | 9.74E-06 | 2.2E-05 |
| | | Antimony | 2.72E+00 | mg/kg | 7.35E-02 | mg/kg | 7.35E-02 | 1.11E-06 | 2.50E-06 | mg/kg-d | 4.0E-04 | mg/kg-d | 2.79E-03 | 6.2E-03 |
| | | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 4.36E-07 | 9.76E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.45E-03 | 3.3E-03 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 1.55E+02 | mg/kg | 6.29E-01 | mg/kg | 6.29E-01 | 9.53E-06 | 2.13E-05 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.76E-05 | 1.1E-04 |
| | | Chromium | 8.55E-01 | mg/kg | 1.27E-01 | mg/kg | 1.27E-01 | 1.92E-06 | 4.31E-06 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.28E-06 | 2.9E-06 |
| | | Cobalt | 3.35E-01 | mg/kg | 1.81E-01 | mg/kg | 1.81E-01 | 2.74E-06 | 6.14E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.14E-03 | 2.0E-02 |
| | | Iron | 2.96E+01 | mg/kg | 1.60E+01 | mg/kg | 1.60E+01 | 2.42E-04 | 5.42E-04 | mg/kg-d | 7.0E-01 | mg/kg-d | 3.46E-04 | 7.7E-04 |
| | | Manganese | 7.15E+02 | mg/kg | 7.72E+00 | mg/kg | 7.72E+00 | 1.17E-04 | 2.62E-04 | mg/kg-d | 1.4E-01 | mg/kg-d | 8.36E-04 | 1.9E-03 |
| | | Mercury | 2.10E-01 | mg/kg | 1.42E+00 | mg/kg | 1.42E+00 | 2.15E-05 | 4.81E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 7.16E-02 | 1.6E-01 |
| | | Thallium | 1.62E-02 | mg/kg | 1.75E-02 | mg/kg | 1.75E-02 | 2.65E-07 | 5.94E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 2.65E-02 | 5.9E-02 |
| | | Vanadium | 6.45E-02 | mg/kg | 4.35E-03 | mg/kg | 4.35E-03 | 6.60E-08 | 1.48E-07 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.32E-05 | 3.0E-05 |
| | | | | | | | | | | | | **Hazard Index** | 1.13E-01 | 2.53E-01 |
| Small Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 1.59E+01 | mg/kg | 1.59E+01 | 1.68E-04 | 3.76E-04 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.68E-04 | 3.8E-04 |
| | | Antimony | 2.72E+00 | mg/kg | 2.72E+00 | mg/kg | 2.72E+00 | 2.88E-05 | 6.45E-05 | mg/kg-d | 4.0E-04 | mg/kg-d | 7.20E-02 | 1.6E-01 |
| | | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 5.62E-06 | 1.26E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.87E-02 | 4.2E-02 |
| | | Arsenic (inorganic) | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 1.55E+02 | mg/kg | 1.55E+02 | mg/kg | 1.55E+02 | 1.64E-03 | 3.68E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 8.20E-03 | 1.8E-02 |
| | | Chromium | 8.55E-01 | mg/kg | 8.55E-01 | mg/kg | 8.55E-01 | 9.04E-06 | 2.02E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 6.03E-06 | 1.3E-05 |
| | | Cobalt | 3.35E-01 | mg/kg | 3.35E-01 | mg/kg | 3.35E-01 | 3.54E-06 | 7.93E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.18E-02 | 2.6E-02 |
| | | Iron | 2.96E+01 | mg/kg | 2.96E+01 | mg/kg | 2.96E+01 | 3.13E-04 | 7.00E-04 | mg/kg-d | 7.0E-01 | mg/kg-d | 4.47E-04 | 1.0E-03 |
| | | Manganese | 7.15E+02 | mg/kg | 7.15E+02 | mg/kg | 7.15E+02 | 7.56E-03 | 1.69E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 5.40E-02 | 1.2E-01 |
| | | Mercury | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 2.22E-06 | 4.97E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 7.40E-03 | 1.7E-02 |
| | | Thallium | 1.62E-02 | mg/kg | 1.62E-02 | mg/kg | 1.62E-02 | 1.71E-07 | 3.84E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.71E-02 | 3.8E-02 |
| | | Vanadium | 6.45E-02 | mg/kg | 6.45E-02 | mg/kg | 6.45E-02 | 6.82E-07 | 1.53E-06 | mg/kg-d | 5.0E-03 | mg/kg-d | 1.36E-04 | 3.1E-04 |
| | | | | | | | | | | | | **Hazard Index** | 1.90E-01 | 4.26E-01 |

# Table D-9
# CALCULATION OF NON-CANCER HAZARDS
# RED DEVIL MINE

Scenario Timeframe: Current/Future
Receptor Population: Recreational/Subsistence User
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birds | Ingestion | Aluminum | 1.30E+02 | mg/kg | 1.30E+02 | mg/kg | 1.30E+02 | 6.64E-03 | 1.49E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 6.64E-03 | 1.5E-02 |
| | | Antimony | 1.03E+01 | mg/kg | 1.03E+01 | mg/kg | 1.03E+01 | 5.29E-04 | 1.18E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **1.32E+00** | **3.0E+00** |
| | | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 3.88E-04 | 8.70E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.29E+00** | **2.9E+00** |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Barium | 5.99E+01 | mg/kg | 5.99E+01 | mg/kg | 5.99E+01 | 3.07E-03 | 6.87E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.53E-02 | 3.4E-02 |
| | | Chromium | 8.35E-01 | mg/kg | 8.35E-01 | mg/kg | 8.35E-01 | 4.28E-05 | 9.58E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 2.85E-05 | 6.4E-05 |
| | | Cobalt | 2.33E-01 | mg/kg | 2.33E-01 | mg/kg | 2.33E-01 | 1.19E-05 | 2.67E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.98E-02 | 8.9E-02 |
| | | Iron | 1.97E+02 | mg/kg | 1.97E+02 | mg/kg | 1.97E+02 | 1.01E-02 | 2.26E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.44E-02 | 3.2E-02 |
| | | Manganese | 1.90E+03 | mg/kg | 1.90E+03 | mg/kg | 1.90E+03 | 9.76E-02 | 2.19E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | 6.97E-01 | **1.6E+00** |
| | | Mercury | 5.64E+00 | mg/kg | 5.64E+00 | mg/kg | 5.64E+00 | 2.89E-04 | 6.47E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.63E-01 | **2.2E+00** |
| | | Thallium | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 1.08E-05 | 2.41E-05 | mg/kg-d | 1.0E-05 | mg/kg-d | **1.08E+00** | **2.4E+00** |
| | | Vanadium | 9.17E-01 | mg/kg | 9.17E-01 | mg/kg | 9.17E-01 | 4.70E-05 | 1.05E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 9.40E-03 | 2.1E-02 |
| | | | | | | | | | | | | **Hazard Index** | **5.44E+00** | **1.22E+01** |
| Berries and Plants | Ingestion | Aluminum | 9.28E+03 | mg/kg | 6.03E+00 | mg/kg | 6.03E+00 | 1.23E-05 | 2.76E-05 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.23E-05 | 2.8E-05 |
| | | Antimony | 3.78E+03 | mg/kg | 1.14E+02 | mg/kg | 1.14E+02 | 2.32E-04 | 5.19E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 5.80E-01 | **1.3E+00** |
| | | Arsenic | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 3.53E+01 | mg/kg | 3.53E+01 | 7.21E-05 | 1.62E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.40E-01 | 5.4E-01 |
| | | Barium | 3.22E+02 | mg/kg | 4.84E+00 | mg/kg | 4.84E+00 | 9.88E-06 | 2.21E-05 | mg/kg-d | 2.0E-01 | mg/kg-d | 4.94E-05 | 1.1E-04 |
| | | Chromium | 2.35E+01 | mg/kg | 1.06E-01 | mg/kg | 1.06E-01 | 2.16E-07 | 4.83E-07 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.44E-07 | 3.2E-07 |
| | | Cobalt | 1.58E+01 | mg/kg | 1.11E-01 | mg/kg | 1.11E-01 | 2.26E-07 | 5.06E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 7.53E-04 | 1.7E-03 |
| | | Iron | 3.67E+04 | mg/kg | 3.67E+01 | mg/kg | 3.67E+01 | 7.49E-05 | 1.68E-04 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.07E-04 | 2.4E-04 |
| | | Manganese | 7.14E+02 | mg/kg | 3.57E+01 | mg/kg | 3.57E+01 | 7.29E-05 | 1.63E-04 | mg/kg-d | 1.4E-01 | mg/kg-d | 5.21E-04 | 1.2E-03 |
| | | Mercury | 3.73E+02 | mg/kg | 7.46E+01 | mg/kg | 7.46E+01 | 1.52E-04 | 3.41E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.08E-01 | **1.1E+00** |
| | | Thallium | 1.71E-01 | mg/kg | 6.84E-05 | mg/kg | 6.84E-05 | 1.40E-10 | 3.13E-10 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.40E-05 | 3.1E-05 |
| | | Vanadium | 3.11E+01 | mg/kg | 9.33E-02 | mg/kg | 9.33E-02 | 1.91E-07 | 4.27E-07 | mg/kg-d | 5.0E-03 | mg/kg-d | 3.81E-05 | 8.5E-05 |
| | | | | | | | | | | | | **Hazard Index** | **1.33E+00** | **2.98E+00** |
| | | | | | | | | | | | | **Total Hazard Index** | **1.24E+02** | **3.58E+02** |

## Table D-10
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Mine Worker
Receptor Age: Adult

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Aluminum | 9.28E+03 | mg/kg | 9.28E+03 | mg/kg | 9.28E+03 | 9.08E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 9.08E-03 |
| | | Antimony | 3.78E+03 | mg/kg | 3.78E+03 | mg/kg | 3.78E+03 | 3.70E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **9.26E+00** |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 3.45E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.15E+01** |
| | | Barium | 3.22E+02 | mg/kg | 3.22E+02 | mg/kg | 3.22E+02 | 3.15E-04 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.58E-03 |
| | | Chromium | 2.35E+01 | mg/kg | 2.35E+01 | mg/kg | 2.35E+01 | 2.29E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.53E-05 |
| | | Cobalt | 1.58E+01 | mg/kg | 1.58E+01 | mg/kg | 1.58E+01 | 1.55E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.15E-02 |
| | | Iron | 3.67E+04 | mg/kg | 3.67E+04 | mg/kg | 3.67E+04 | 3.59E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 5.12E-02 |
| | | Manganese | 7.14E+02 | mg/kg | 7.14E+02 | mg/kg | 7.14E+02 | 6.98E-04 | mg/kg-d | 2.4E-02 | mg/kg-d | 2.91E-02 |
| | | Mercury | 3.73E+02 | mg/kg | 3.73E+02 | mg/kg | 3.73E+02 | 3.65E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.22E+00** |
| | | Thallium | 1.71E-01 | mg/kg | 1.71E-01 | mg/kg | 1.71E-01 | 1.67E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.67E-02 |
| | | Vanadium | 3.11E+01 | mg/kg | 3.11E+01 | mg/kg | 3.11E+01 | 3.04E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.09E-03 |
| | | | | | | | | | | | **Hazard Index** | **2.22E+01** |
| Soil | Dermal | Aluminum | 9.28E+03 | mg/kg | 9.28E+03 | mg/kg | 9.28E+03 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 |
| | | Antimony | 3.78E+03 | mg/kg | 3.78E+03 | mg/kg | 3.78E+03 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 5.88E+03 | mg/kg | 5.88E+03 | 1.14E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.80E+00** |
| | | Barium | 3.22E+02 | mg/kg | 3.22E+02 | mg/kg | 3.22E+02 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 |
| | | Chromium | 2.35E+01 | mg/kg | 2.35E+01 | mg/kg | 2.35E+01 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 |
| | | Cobalt | 1.58E+01 | mg/kg | 1.58E+01 | mg/kg | 1.58E+01 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Iron | 3.67E+04 | mg/kg | 3.67E+04 | mg/kg | 3.67E+04 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 |
| | | Manganese | 7.14E+02 | mg/kg | 7.14E+02 | mg/kg | 7.14E+02 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 |
| | | Mercury | 3.73E+02 | mg/kg | 3.73E+02 | mg/kg | 3.73E+02 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 |
| | | Thallium | 1.71E-01 | mg/kg | 1.71E-01 | mg/kg | 1.71E-01 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 |
| | | Vanadium | 3.11E+01 | mg/kg | 3.11E+01 | mg/kg | 3.11E+01 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 |
| | | | | | | | | | | | **Hazard Index** | **3.80E+00** |

## Table D-10
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Mine Worker
Receptor Age: Adult

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sediment | Dermal | Aluminum | 1.08E+04 | mg/kg | 1.08E+04 | mg/kg | 1.08E+04 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | 0.00E+00 |
| | | Antimony | 4.46E+03 | mg/kg | 4.46E+03 | mg/kg | 4.46E+03 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | 0.00E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Arsenic (Inorganic) | 6.00E+04 | mg/kg | 6.00E+04 | mg/kg | 6.00E+04 | 4.19E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.40E+01** |
| | | Barium | 6.81E+02 | mg/kg | 6.81E+02 | mg/kg | 6.81E+02 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | 0.00E+00 |
| | | Cadmium | 2.92E-01 | mg/kg | 2.92E-01 | mg/kg | 2.92E-01 | 0.00E+00 | mg/kg-d | 2.5E-05 | mg/kg-d | 0.00E+00 |
| | | Chromium | 2.57E+01 | mg/kg | 2.57E+01 | mg/kg | 2.57E+01 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 |
| | | Cobalt | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Copper | 3.72E+01 | mg/kg | 3.72E+01 | mg/kg | 3.72E+01 | 0.00E+00 | mg/kg-d | 4.0E-02 | mg/kg-d | 0.00E+00 |
| | | Iron | 9.92E+04 | mg/kg | 9.92E+04 | mg/kg | 9.92E+04 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 0.00E+00 |
| | | Manganese | 2.02E+03 | mg/kg | 2.02E+03 | mg/kg | 2.02E+03 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | 0.00E+00 |
| | | Mercury | 6.66E+01 | mg/kg | 6.66E+01 | mg/kg | 6.66E+01 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | 0.00E+00 |
| | | Methyl Mercury | 5.23E-03 | mg/kg | 5.23E-03 | mg/kg | 5.23E-03 | 0.00E+00 | mg/kg-d | 1.0E-04 | mg/kg-d | 0.00E+00 |
| | | Nickel | 5.70E+01 | mg/kg | 5.70E+01 | mg/kg | 5.70E+01 | 0.00E+00 | mg/kg-d | 8.0E-04 | mg/kg-d | 0.00E+00 |
| | | Selenium | 4.87E-01 | mg/kg | 4.87E-01 | mg/kg | 4.87E-01 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 |
| | | Silver | 1.14E-01 | mg/kg | 1.14E-01 | mg/kg | 1.14E-01 | 0.00E+00 | mg/kg-d | 2.0E-04 | mg/kg-d | 0.00E+00 |
| | | Thallium | 1.49E-01 | mg/kg | 1.49E-01 | mg/kg | 1.49E-01 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 |
| | | Vanadium | 3.10E+01 | mg/kg | 3.10E+01 | mg/kg | 3.10E+01 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 |
| | | Zinc | 9.16E+01 | mg/kg | 9.16E+01 | mg/kg | 9.16E+01 | 0.00E+00 | mg/kg-d | 3.0E-01 | mg/kg-d | 0.00E+00 |
| | | | | | | | | | | | **Hazard Index** | **1.40E+01** |
| Groundwater | Ingestion | Antimony | 5.61E+03 | ug/L | 5.61E+03 | ug/L | 5.61E+03 | 1.10E-01 | mg/kg-d | 4.0E-04 | mg/kg-d | **2.74E+02** |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+03 | ug/L | 1.80E+03 | 3.53E-02 | mg/kg-d | 3.0E-04 | mg/kg-d | **1.18E+02** |
| | | Barium | 1.01E+02 | ug/L | 1.01E+02 | ug/L | 1.01E+02 | 1.97E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 9.84E-03 |
| | | Chromium | 3.51E+00 | ug/L | 3.51E+00 | ug/L | 3.51E+00 | 6.86E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 4.57E-05 |
| | | Cobalt | 9.79E+00 | ug/L | 9.79E+00 | ug/L | 9.79E+00 | 1.91E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.38E-01 |
| | | Iron | 8.04E+03 | ug/L | 8.04E+03 | ug/L | 8.04E+03 | 1.57E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.25E-01 |
| | | Manganese | 2.24E+03 | ug/L | 2.24E+03 | ug/L | 2.24E+03 | 4.39E-02 | mg/kg-d | 2.4E-02 | mg/kg-d | **1.83E+00** |
| | | Mercury | 1.48E+01 | ug/L | 1.48E+01 | ug/L | 1.48E+01 | 2.89E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.65E-01 |
| | | Nickel | 1.73E+01 | ug/L | 1.73E+01 | ug/L | 1.73E+01 | 3.38E-04 | mg/kg-d | 2.0E-02 | mg/kg-d | 1.69E-02 |
| | | Selenium | 9.17E-01 | ug/L | 9.17E-01 | ug/L | 9.17E-01 | 1.79E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 3.59E-03 |
| | | Thallium | 1.71E-02 | ug/L | 1.71E-02 | ug/L | 1.71E-02 | 3.35E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 3.35E-02 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 1.12E-04 | mg/kg-d | 2.0E-02 | mg/kg-d | 5.58E-03 |
| | | | | | | | | | | | **Hazard Index** | **3.96E+02** |

# Table D-10
# CALCULATION OF NON-CANCER HAZARDS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Mine Worker
Receptor Age: Adult

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | Dermal | Antimony | 5.61E+03 | ug/L | 5.61E+00 | mg/L | 5.61E+00 | 2.47E-04 | mg/kg-d | 6.0E-05 | mg/kg-d | **4.12E+00** |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Arsenic (Inorganic) | 1.80E+03 | ug/L | 1.80E+00 | mg/L | 1.80E+00 | 7.93E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.64E-01 |
| | | Barium | 1.01E+02 | ug/L | 1.01E-01 | mg/L | 1.01E-01 | 4.43E-06 | mg/kg-d | 1.4E-02 | mg/kg-d | 3.16E-04 |
| | | Chromium | 3.51E+00 | ug/L | 3.51E-03 | mg/L | 3.51E-03 | 1.54E-07 | mg/kg-d | 2.0E-02 | mg/kg-d | 7.72E-06 |
| | | Cobalt | 9.79E+00 | ug/L | 9.79E-03 | mg/L | 9.79E-03 | 1.72E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.74E-04 |
| | | Iron | 8.04E+03 | ug/L | 8.04E+00 | mg/L | 8.04E+00 | 3.54E-04 | mg/kg-d | 7.0E-01 | mg/kg-d | 5.06E-04 |
| | | Manganese | 2.24E+03 | ug/L | 2.24E+00 | mg/L | 2.24E+00 | 9.88E-05 | mg/kg-d | 9.6E-04 | mg/kg-d | 1.03E-01 |
| | | Mercury | 1.48E+01 | ug/L | 1.48E-02 | mg/L | 1.48E-02 | 6.51E-07 | mg/kg-d | 2.1E-05 | mg/kg-d | 3.10E-02 |
| | | Nickel | 1.73E+01 | ug/L | 1.73E-02 | mg/L | 1.73E-02 | 1.52E-07 | mg/kg-d | 8.0E-04 | mg/kg-d | 1.90E-04 |
| | | Selenium | 9.17E-01 | ug/L | 9.17E-04 | mg/L | 9.17E-04 | 4.04E-08 | mg/kg-d | 5.0E-03 | mg/kg-d | 8.08E-06 |
| | | Thallium | 1.71E-02 | ug/L | 1.71E-05 | mg/L | 1.71E-05 | 7.53E-10 | mg/kg-d | 1.0E-05 | mg/kg-d | 7.53E-05 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 |
| | | | | | | | | | | | **Hazard Index** | **4.52E+00** |
| Surface Water | Dermal | Antimony | 1.36E+02 | ug/L | 1.36E-01 | mg/L | 1.36E-01 | 1.20E-06 | mg/kg-d | 6.0E-05 | mg/kg-d | 2.01E-02 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 5.08E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.69E-02 |
| | | Cadmium | 6.00E-03 | ug/L | 6.00E-06 | mg/L | 6.00E-06 | 5.33E-11 | mg/kg-d | 2.5E-05 | mg/kg-d | 2.13E-06 |
| | | Cobalt | 3.04E+00 | ug/L | 3.04E-03 | mg/L | 3.04E-03 | 1.08E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.60E-05 |
| | | Copper | 4.31E-01 | ug/L | 4.31E-04 | mg/L | 4.31E-04 | 3.83E-09 | mg/kg-d | 4.0E-02 | mg/kg-d | 9.57E-08 |
| | | Iron | 1.33E+03 | ug/L | 1.33E+00 | mg/L | 1.33E+00 | 1.18E-05 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.68E-05 |
| | | Manganese | 1.71E+02 | ug/L | 1.71E-01 | mg/L | 1.71E-01 | 1.51E-06 | mg/kg-d | 9.6E-04 | mg/kg-d | 1.58E-03 |
| | | Mercury | 2.41E-01 | ug/L | 2.41E-04 | mg/L | 2.41E-04 | 2.14E-09 | mg/kg-d | 2.1E-05 | mg/kg-d | 1.02E-04 |
| | | Methyl Mercury | 3.13E-04 | ug/L | 3.13E-07 | mg/L | 3.13E-07 | 2.78E-12 | mg/kg-d | 1.0E-04 | mg/kg-d | 2.78E-08 |
| | | Nickel | 1.05E+01 | ug/L | 1.05E-02 | mg/L | 1.05E-02 | 1.87E-08 | mg/kg-d | 8.0E-04 | mg/kg-d | 2.34E-05 |
| | | Selenium | 3.85E-01 | ug/L | 3.85E-04 | mg/L | 3.85E-04 | 3.42E-09 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.84E-07 |
| | | Silver | 2.60E-02 | ug/L | 2.60E-05 | mg/L | 2.60E-05 | 1.39E-10 | mg/kg-d | 2.0E-04 | mg/kg-d | 6.93E-07 |
| | | Zinc | 7.27E-01 | ug/L | 7.27E-04 | mg/L | 7.27E-04 | 3.87E-09 | mg/kg-d | 3.0E-01 | mg/kg-d | 1.29E-08 |
| | | 1-Methylnaphthalene | 1.50E+00 | ug/L | 1.50E-03 | mg/L | 1.50E-03 | 0.00E+00 | mg/kg-d | 7.0E-02 | mg/kg-d | 0.00E+00 |
| | | Naphthalene | 6.80E-01 | ug/L | 6.80E-04 | mg/L | 6.80E-04 | 2.84E-07 | mg/kg-d | 2.0E-02 | mg/kg-d | 1.42E-05 |
| | | | | | | | | | | | **Hazard Index** | 3.88E-02 |
| Air | Dust Particulates or Volatile from Soil | Aluminum | 9.28E+03 | mg/kg | 1.36E-05 | mg/m3 | 1.36E-05 | 3.12E-06 | mg/m3 | 5.0E-03 | mg/m3 | 6.23E-04 |
| | | Antimony | 3.78E+03 | mg/kg | 5.56E-06 | mg/m3 | 5.56E-06 | 1.27E-06 | mg/m3 | -- | mg/m3 | -- |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/m3 | 0.00E+00 | 0.00E+00 | mg/m3 | 1.5E-05 | mg/m3 | 0.00E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 8.65E-06 | mg/m3 | 8.65E-06 | 1.19E-06 | mg/m3 | 1.5E-05 | mg/m3 | 7.90E-02 |
| | | Barium | 3.22E+02 | mg/kg | 4.74E-07 | mg/m3 | 4.74E-07 | 1.08E-07 | mg/m3 | 5.0E-04 | mg/m3 | 2.16E-04 |
| | | Chromium | 2.35E+01 | mg/kg | 3.45E-08 | mg/m3 | 3.45E-08 | 7.87E-09 | mg/m3 | -- | mg/m3 | -- |
| | | Cobalt | 1.58E+01 | mg/kg | 2.32E-08 | mg/m3 | 2.32E-08 | 5.30E-09 | mg/m3 | 6.0E-06 | mg/m3 | 8.84E-04 |
| | | Iron | 3.67E+04 | mg/kg | 5.39E-05 | mg/m3 | 5.39E-05 | 1.23E-05 | mg/m3 | -- | mg/m3 | -- |
| | | Manganese | 7.14E+02 | mg/kg | 1.05E-06 | mg/m3 | 1.05E-06 | 2.40E-07 | mg/m3 | 5.0E-05 | mg/m3 | 4.79E-03 |
| | | Mercury | 3.73E+02 | mg/kg | 1.67E-02 | mg/m3 | 1.67E-02 | 3.82E-03 | mg/m3 | 3.0E-04 | mg/m3 | **1.27E+01** |
| | | Thallium | 1.71E-01 | mg/kg | 2.51E-10 | mg/m3 | 2.51E-10 | 5.74E-11 | mg/m3 | -- | mg/m3 | -- |
| | | Vanadium | 3.11E+01 | mg/kg | 4.57E-08 | mg/m3 | 4.57E-08 | 1.04E-08 | mg/m3 | -- | mg/m3 | -- |
| | | | | | | | | | | | **Hazard Index** | **1.28E+01** |

# Table D-10
# CALCULATION OF NON-CANCER HAZARDS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Mine Worker
Receptor Age: Adult

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Aluminum | 3.22E+01 | mg/kg | 3.22E+01 | mg/kg | 3.22E+01 | 1.71E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.71E-02 |
| | | Antimony | 1.71E+01 | mg/kg | 1.71E+01 | mg/kg | 1.71E+01 | 9.05E-03 | mg/kg-d | 4.0E-04 | mg/kg-d | **2.26E+01** |
| | | Arsenic | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+00 | 6.05E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | **2.02E+00** |
| | | Arsenic (Inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Barium | 3.79E+00 | mg/kg | 3.79E+00 | mg/kg | 3.79E+00 | 2.01E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.00E-02 |
| | | Cadmium | 4.42E-02 | mg/kg | 4.42E-02 | mg/kg | 4.42E-02 | 2.34E-05 | mg/kg-d | 1.0E-03 | mg/kg-d | 2.34E-02 |
| | | Chromium | 6.80E-01 | mg/kg | 6.80E-01 | mg/kg | 6.80E-01 | 3.61E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 2.40E-04 |
| | | Cobalt | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Copper | 1.25E+00 | mg/kg | 1.25E+00 | mg/kg | 1.25E+00 | 6.64E-04 | mg/kg-d | 4.0E-02 | mg/kg-d | 1.66E-02 |
| | | Iron | 8.89E+01 | mg/kg | 8.89E+01 | mg/kg | 8.89E+01 | 4.71E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | 6.73E-02 |
| | | Manganese | 1.25E+01 | mg/kg | 1.25E+01 | mg/kg | 1.25E+01 | 6.63E-03 | mg/kg-d | 1.4E-01 | mg/kg-d | 4.74E-02 |
| | | Mercury | 2.14E+00 | mg/kg | 6.42E+00 | mg/kg | 6.42E+00 | 3.40E-03 | mg/kg-d | 1.0E-04 | mg/kg-d | **3.40E+01** |
| | | Methyl Mercury | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | | mg/kg-d | |
| | | Nickel | 1.47E-01 | mg/kg | 1.47E-01 | mg/kg | 1.47E-01 | 7.80E-05 | mg/kg-d | 2.0E-02 | mg/kg-d | 3.90E-03 |
| | | Selenium | 1.89E+00 | mg/kg | 1.89E+00 | mg/kg | 1.89E+00 | 1.00E-03 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.01E-01 |
| | | Silver | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | 0.00E+00 |
| | | Thallium | -- | mg/kg | -- | mg/kg | -- | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | 0.00E+00 |
| | | Vanadium | 2.21E-01 | mg/kg | 2.21E-01 | mg/kg | 2.21E-01 | 1.17E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.34E-02 |
| | | Zinc | 2.66E+01 | mg/kg | 2.66E+01 | mg/kg | 2.66E+01 | 1.41E-02 | mg/kg-d | 3.0E-01 | mg/kg-d | 4.70E-02 |
| | | | | | | | | | | | **Hazard Index** | **5.91E+01** |
| Large Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 6.43E-01 | mg/kg | 6.43E-01 | 6.67E-06 | mg/kg-d | 1.0E+00 | mg/kg-d | 6.67E-06 |
| | | Antimony | 2.72E+00 | mg/kg | 7.35E-02 | mg/kg | 7.35E-02 | 7.64E-07 | mg/kg-d | 4.0E-04 | mg/kg-d | 1.91E-03 |
| | | Arsenic | 5.32E-01 | mg/kg | 2.87E-02 | mg/kg | 2.87E-02 | 2.98E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.94E-04 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Barium | 1.55E+02 | mg/kg | 6.29E-01 | mg/kg | 6.29E-01 | 6.53E-06 | mg/kg-d | 2.0E-01 | mg/kg-d | 3.26E-05 |
| | | Chromium | 8.55E-01 | mg/kg | 1.27E-01 | mg/kg | 1.27E-01 | 1.32E-06 | mg/kg-d | 1.5E+00 | mg/kg-d | 8.79E-07 |
| | | Cobalt | 3.35E-01 | mg/kg | 1.81E-01 | mg/kg | 1.81E-01 | 1.88E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.26E-03 |
| | | Iron | 2.96E+01 | mg/kg | 1.60E+01 | mg/kg | 1.60E+01 | 1.66E-04 | mg/kg-d | 7.0E-01 | mg/kg-d | 2.37E-04 |
| | | Manganese | 7.15E+02 | mg/kg | 7.72E+00 | mg/kg | 7.72E+00 | 8.02E-05 | mg/kg-d | 1.4E-01 | mg/kg-d | 5.73E-04 |
| | | Mercury | 2.10E-01 | mg/kg | 1.42E+00 | mg/kg | 1.42E+00 | 1.47E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 4.91E-02 |
| | | Thallium | 1.62E-02 | mg/kg | 1.75E-02 | mg/kg | 1.75E-02 | 1.82E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.82E-02 |
| | | Vanadium | 6.45E-02 | mg/kg | 4.35E-03 | mg/kg | 4.35E-03 | 4.52E-08 | mg/kg-d | 5.0E-03 | mg/kg-d | 9.04E-06 |
| | | | | | | | | | | | **Hazard Index** | 7.73E-02 |
| Small Land Mammal | Ingestion | Aluminum | 1.59E+01 | mg/kg | 1.59E+01 | mg/kg | 1.59E+01 | 1.15E-04 | mg/kg-d | 1.0E+00 | mg/kg-d | 1.15E-04 |
| | | Antimony | 2.72E+00 | mg/kg | 2.72E+00 | mg/kg | 2.72E+00 | 1.97E-05 | mg/kg-d | 4.0E-04 | mg/kg-d | 4.93E-02 |
| | | Arsenic | 5.32E-01 | mg/kg | 5.32E-01 | mg/kg | 5.32E-01 | 3.85E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.28E-02 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Barium | 1.55E+02 | mg/kg | 1.55E+02 | mg/kg | 1.55E+02 | 1.12E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 5.62E-03 |
| | | Chromium | 8.55E-01 | mg/kg | 8.55E-01 | mg/kg | 8.55E-01 | 6.19E-06 | mg/kg-d | 1.5E+00 | mg/kg-d | 4.13E-06 |
| | | Cobalt | 3.35E-01 | mg/kg | 3.35E-01 | mg/kg | 3.35E-01 | 2.43E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.09E-03 |
| | | Iron | 2.96E+01 | mg/kg | 2.96E+01 | mg/kg | 2.96E+01 | 2.14E-04 | mg/kg-d | 7.0E-01 | mg/kg-d | 3.06E-04 |
| | | Manganese | 7.15E+02 | mg/kg | 7.15E+02 | mg/kg | 7.15E+02 | 5.18E-03 | mg/kg-d | 1.4E-01 | mg/kg-d | 3.70E-02 |
| | | Mercury | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 1.52E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.07E-03 |
| | | Thallium | 1.62E-02 | mg/kg | 1.62E-02 | mg/kg | 1.62E-02 | 1.17E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | 1.17E-02 |
| | | Vanadium | 6.45E-02 | mg/kg | 6.45E-02 | mg/kg | 6.45E-02 | 4.67E-07 | mg/kg-d | 5.0E-03 | mg/kg-d | 9.34E-05 |
| | | | | | | | | | | | **Hazard Index** | 1.30E-01 |

## Table D-10
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Mine Worker
Receptor Age: Adult

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birds | Ingestion | Aluminum | 1.30E+02 | mg/kg | 1.30E+02 | mg/kg | 1.30E+02 | 4.55E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | 4.55E-03 |
| | | Antimony | 1.03E+01 | mg/kg | 1.03E+01 | mg/kg | 1.03E+01 | 3.62E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 9.06E-01 |
| | | Arsenic | 7.58E+00 | mg/kg | 7.58E+00 | mg/kg | 7.58E+00 | 2.66E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 8.86E-01 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Barium | 5.99E+01 | mg/kg | 5.99E+01 | mg/kg | 5.99E+01 | 2.10E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | 1.05E-02 |
| | | Chromium | 8.35E-01 | mg/kg | 8.35E-01 | mg/kg | 8.35E-01 | 2.93E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.95E-05 |
| | | Cobalt | 2.33E-01 | mg/kg | 2.33E-01 | mg/kg | 2.33E-01 | 8.18E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 2.73E-02 |
| | | Iron | 1.97E+02 | mg/kg | 1.97E+02 | mg/kg | 1.97E+02 | 6.92E-03 | mg/kg-d | 7.0E-01 | mg/kg-d | 9.89E-03 |
| | | Manganese | 1.90E+03 | mg/kg | 1.90E+03 | mg/kg | 1.90E+03 | 6.68E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | 4.77E-01 |
| | | Mercury | 5.64E+00 | mg/kg | 5.64E+00 | mg/kg | 5.64E+00 | 1.98E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 6.60E-01 |
| | | Thallium | 2.10E-01 | mg/kg | 2.10E-01 | mg/kg | 2.10E-01 | 7.37E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | 7.37E-01 |
| | | Vanadium | 9.17E-01 | mg/kg | 9.17E-01 | mg/kg | 9.17E-01 | 3.22E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.44E-03 |
| | | | | | | | | | | | **Hazard Index** | **3.72E+00** |
| Berries and Plants | Ingestion | Aluminum | 9.28E+03 | mg/kg | 6.03E+00 | mg/kg | 6.03E+00 | 8.44E-06 | mg/kg-d | 1.0E+00 | mg/kg-d | 8.44E-06 |
| | | Antimony | 3.78E+03 | mg/kg | 1.14E+02 | mg/kg | 1.14E+02 | 1.59E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | 3.97E-01 |
| | | Arsenic | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 |
| | | Arsenic (inorganic) | 5.88E+03 | mg/kg | 3.53E+01 | mg/kg | 3.53E+01 | 4.94E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | 1.65E-01 |
| | | Barium | 3.22E+02 | mg/kg | 4.84E+00 | mg/kg | 4.84E+00 | 6.77E-06 | mg/kg-d | 2.0E-01 | mg/kg-d | 3.38E-05 |
| | | Chromium | 2.35E+01 | mg/kg | 1.06E-01 | mg/kg | 1.06E-01 | 1.48E-07 | mg/kg-d | 1.5E+00 | mg/kg-d | 9.84E-08 |
| | | Cobalt | 1.58E+01 | mg/kg | 1.11E-01 | mg/kg | 1.11E-01 | 1.55E-07 | mg/kg-d | 3.0E-04 | mg/kg-d | 5.16E-04 |
| | | Iron | 3.67E+04 | mg/kg | 3.67E+01 | mg/kg | 3.67E+01 | 5.13E-05 | mg/kg-d | 7.0E-01 | mg/kg-d | 7.33E-05 |
| | | Manganese | 7.14E+02 | mg/kg | 3.57E+01 | mg/kg | 3.57E+01 | 4.99E-05 | mg/kg-d | 1.4E-01 | mg/kg-d | 3.57E-04 |
| | | Mercury | 3.73E+02 | mg/kg | 7.46E+01 | mg/kg | 7.46E+01 | 1.04E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.48E-01 |
| | | Thallium | 1.71E-01 | mg/kg | 6.84E-05 | mg/kg | 6.84E-05 | 9.57E-11 | mg/kg-d | 1.0E-05 | mg/kg-d | 9.57E-06 |
| | | Vanadium | 3.11E+01 | mg/kg | 9.33E-02 | mg/kg | 9.33E-02 | 1.31E-07 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.61E-05 |
| | | | | | | | | | | | **Hazard Index** | 9.11E-01 |

| | |
|---|---|
| **Total Hazard Index** | **5.17E+02** |

# Table D-11
# CALCULATION OF CANCER RISKS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Maximum Groundwater
Receptor Age: Combined Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | Ingestion | Arsenic (Inorganic) | 4.53E+03 | ug/L | 4.53E+03 | ug/L | 4.53E+03 | 6.74E-02 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **1.01E-01** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 8.48E-05 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 1.19E-06 |
| Groundwater | Dermal | Arsenic (Inorganic) | 4.53E+03 | ug/L | 4.53E+00 | mg/L | 4.53E+00 | 1.50E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.25E-04** |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |

| | |
|---|---|
| **Cancer Risk** | **1.01E-01** |

## Table D-12
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Maximum
Receptor Age: Adult/Child

| Medium | Exposure Rote | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | Ingestion | Antimony | 1.31E+04 | ug/L | 1.31E+04 | ug/L | 1.31E+04 | 3.59E-01 | 8.37E-01 | mg/kg-d | 4.0E-04 | mg/kg-d | **8.97E+02** | **2.1E+03** |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 4.53E+03 | ug/L | 4.53E+03 | ug/L | 4.53E+03 | 1.24E-01 | 2.90E-01 | mg/kg-d | 3.0E-04 | mg/kg-d | **4.14E+02** | **9.7E+02** |
| | | Barium | 3.65E+02 | ug/L | 3.65E+02 | ug/L | 3.65E+02 | 1.00E-02 | 2.33E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | 5.00E-02 | 1.2E-01 |
| | | Chromium | 1.06E+01 | ug/L | 1.06E+01 | ug/L | 1.06E+01 | 2.90E-04 | 6.78E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | 1.94E-04 | 4.5E-04 |
| | | Cobalt | 4.05E+01 | ug/L | 4.05E+01 | ug/L | 4.05E+01 | 1.11E-03 | 2.59E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **3.70E+00** | **8.6E+00** |
| | | Iron | 2.24E+04 | ug/L | 2.24E+04 | ug/L | 2.24E+04 | 6.14E-01 | 1.43E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | 8.77E-01 | **2.0E+00** |
| | | Manganese | 7.37E+03 | ug/L | 7.37E+03 | ug/L | 7.37E+03 | 2.02E-01 | 4.71E-01 | mg/kg-d | 2.4E-02 | mg/kg-d | **8.41E+00** | **2.0E+01** |
| | | Mercury | 5.65E+01 | ug/L | 5.65E+01 | ug/L | 5.65E+01 | 1.55E-03 | 3.61E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | **5.16E+00** | **1.2E+01** |
| | | Nickel | 3.59E+01 | ug/L | 3.59E+01 | ug/L | 3.59E+01 | 9.84E-04 | 2.29E-03 | mg/kg-d | 2.0E-02 | mg/kg-d | 4.92E-02 | 1.1E-01 |
| | | Selenium | 5.40E+00 | ug/L | 5.40E+00 | ug/L | 5.40E+00 | 1.48E-04 | 3.45E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | 2.96E-02 | 6.9E-02 |
| | | Thallium | 7.50E-02 | ug/L | 7.50E-02 | ug/L | 7.50E-02 | 2.05E-06 | 4.79E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | 2.05E-01 | 4.8E-01 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E+00 | ug/L | 5.70E+00 | 1.56E-04 | 3.64E-04 | mg/kg-d | 2.0E-02 | mg/kg-d | 7.81E-03 | 1.8E-02 |
| | | | | | | | | | | | | **Hazard Index** | **1.33E+03** | **3.10E+03** |
| Groundwater | Dermal | Antimony | 1.31E+04 | ug/L | 1.31E+01 | mg/L | 1.31E+01 | 8.08E-04 | 1.82E-06 | mg/kg-d | 6.0E-05 | mg/kg-d | **1.35E+01** | 3.0E-02 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 4.53E+03 | ug/L | 4.53E+00 | mg/L | 4.53E+00 | 2.79E-04 | 6.31E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | 9.31E-01 | **2.1E+00** |
| | | Barium | 3.65E+02 | ug/L | 3.65E-01 | mg/L | 3.65E-01 | 2.25E-05 | 5.08E-05 | mg/kg-d | 1.4E-02 | mg/kg-d | 1.61E-03 | 3.6E-03 |
| | | Chromium | 1.06E+01 | ug/L | 1.06E-02 | mg/L | 1.06E-02 | 6.53E-07 | 1.48E-06 | mg/kg-d | 2.0E-02 | mg/kg-d | 3.27E-05 | 7.4E-05 |
| | | Cobalt | 4.05E+01 | ug/L | 4.05E-02 | mg/L | 4.05E-02 | 9.99E-07 | 2.26E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | 3.33E-03 | 7.5E-03 |
| | | Iron | 2.24E+04 | ug/L | 2.24E+01 | mg/L | 2.24E+01 | 1.38E-03 | 3.12E-03 | mg/kg-d | 7.0E-01 | mg/kg-d | 1.97E-03 | 4.5E-03 |
| | | Manganese | 7.37E+03 | ug/L | 7.37E+00 | mg/L | 7.37E+00 | 4.54E-04 | 1.03E-03 | mg/kg-d | 9.6E-04 | mg/kg-d | 4.73E-01 | **1.1E+00** |
| | | Mercury | 5.65E+01 | ug/L | 5.65E-02 | mg/L | 5.65E-02 | 3.48E-06 | 7.87E-06 | mg/kg-d | 2.1E-05 | mg/kg-d | 1.66E-01 | 3.7E-01 |
| | | Nickel | 3.59E+01 | ug/L | 3.59E-02 | mg/L | 3.59E-02 | 4.43E-07 | 1.00E-06 | mg/kg-d | 8.0E-04 | mg/kg-d | 5.53E-04 | 1.2E-03 |
| | | Selenium | 5.40E+00 | ug/L | 5.40E-03 | mg/L | 5.40E-03 | 3.33E-07 | 7.52E-07 | mg/kg-d | 5.0E-03 | mg/kg-d | 6.66E-05 | 1.5E-04 |
| | | Thallium | 7.50E-02 | ug/L | 7.50E-05 | mg/L | 7.50E-05 | 4.62E-09 | 1.04E-08 | mg/kg-d | 1.0E-05 | mg/kg-d | 4.62E-04 | 1.0E-03 |
| | | Bis(2-ethylhexyl)phthalate | 5.70E+00 | ug/L | 5.70E-03 | mg/L | 5.70E-03 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | **Hazard Index** | **1.50E+01** | **3.59E+00** |
| Air | Volatile from Groundwater | Mercury | 5.65E+01 | ug/L | 2.83E-02 | mg/m3 | 2.83E-02 | 8.47E-04 | 8.47E-04 | mg/m3 | 3.0E-04 | mg/m3 | **2.82E+00** | **2.8E+00** |
| | | | | | | | | | | | | **Total Hazard Index** | **1.35E+03** | **3.11E+03** |

# Table D-13
# CALCULATION OF CANCER RISKS
# RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Background
Receptor Age: Combined Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 2.61E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.91E-04** |
| Soil | Dermal | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 4.11E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **6.17E-05** |
| Sediment | Dermal | Arsenic (Inorganic) | 5.28E+01 | mg/kg | 5.28E+01 | mg/kg | 5.28E+01 | 6.04E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 9.06E-06 |
| Groundwater | Ingestion | Arsenic (Inorganic) | 1.35E+01 | ug/L | 1.35E+01 | ug/L | 1.35E+01 | 2.01E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.01E-04** |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Groundwater | Dermal | Arsenic (Inorganic) | 1.35E+01 | ug/L | 1.35E-02 | mg/L | 1.35E-02 | 4.46E-07 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 6.70E-07 |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Surface Water | Dermal | Arsenic (inorganic) | 8.63E-01 | ug/L | 8.63E-04 | mg/L | 8.63E-04 | 7.31E-09 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 1.10E-08 |
| | | 1-Methylnaphthalene | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 3.60E+02 | mg/kg | 5.29E-04 | ug/m3 | 5.29E-04 | 1.01E-04 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 4.33E-07 |
| | | | | | | | | | | | **Cancer Risk** | **7.64E-04** |
| Non-Salmon Fish | Ingestion | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Large Land Mammals | Ingestion | Arsenic | 1.00E-01 | mg/kg | 5.40E-03 | mg/kg | 5.40E-03 | 3.13E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 4.69E-06 |
| Small Land Mammals | Ingestion | Arsenic | 1.00E-01 | mg/kg | 1.00E-01 | mg/kg | 1.00E-01 | 2.83E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **4.24E-05** |
| Birds | Ingestion | Arsenic | 1.10E-01 | mg/kg | 1.10E-01 | mg/kg | 1.10E-01 | 9.14E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **1.37E-05** |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 3.60E+02 | mg/kg | 2.16E+00 | mg/kg | 2.16E+00 | 2.36E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **3.54E-04** |
| | | | | | | | | | | | **Cancer Risk** | **4.14E-04** |

| | |
|---|---|
| **Total Excess Cancer Risk** | **1.18E-03** |

## Table D-14
## CALCULATION OF CANCER RISKS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Rec/Sub User (Background)
Receptor Age: Combined Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 8.69E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **1.30E-04** |
| Soil | Dermal | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 1.37E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.06E-05** |
| Sediment | Dermal | Arsenic (Inorganic) | 5.28E+01 | mg/kg | 5.28E+01 | mg/kg | 5.28E+01 | 2.01E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 3.02E-06 |
| Surface Water | Ingestion | Arsenic (Inorganic) | 5.73E+02 | ug/L | 5.73E+02 | ug/L | 5.73E+02 | 4.87E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **7.30E-04** |
| | | 1-Methylnaphthalene | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Surface Water | Dermal | Arsenic | 5.73E+02 | ug/L | 5.73E-01 | mg/L | 5.73E-01 | 1.62E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 2.42E-06 |
| | | 1-Methylnaphthalene | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 3.60E+02 | mg/kg | 1.15E-04 | ug/m3 | 1.15E-04 | 7.26E-06 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 3.12E-08 |
| | | | | | | | | | | | **Cancer Risk** | **8.86E-04** |
| Non-Salmon Fish | Ingestion | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Large Land Mammals | Ingestion | Arsenic | 1.00E-01 | mg/kg | 5.40E-03 | mg/kg | 5.40E-03 | 4.38E-08 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 6.57E-08 |
| Small Land Mammals | Ingestion | Arsenic | 1.00E-01 | mg/kg | 1.00E-01 | mg/kg | 1.00E-01 | 5.65E-07 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 8.48E-07 |
| Birds | Ingestion | Arsenic | 1.10E-01 | mg/kg | 1.10E-01 | mg/kg | 1.10E-01 | 3.01E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 4.52E-06 |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 3.60E+02 | mg/kg | 2.16E+00 | mg/kg | 2.16E+00 | 2.36E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 3.54E-06 |
| | | | | | | | | | | | | |
| | | | | | | | | | | | **Cancer Risk** | 8.97E-06 |

| | |
|---|---|
| **Total Excess Cancer Risk** | **8.95E-04** |

## Table D-15
## CALCULATION OF CANCER RISKS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Mine Worker - Background
Receptor Age: Combined Adult

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Intake | Intake Units | Slope Factor | Slope Factor Units | Cancer Risk |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 9.05E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **1.36E-04** |
| Soil | Dermal | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 1.95E-05 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **2.92E-05** |
| Sediment | Dermal | Arsenic (Inorganic) | 5.28E+01 | mg/kg | 5.28E+01 | mg/kg | 5.28E+01 | 2.86E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 4.29E-06 |
| Groundwater | Ingestion | Arsenic (Inorganic) | 1.35E+01 | ug/L | 1.35E+01 | ug/L | 1.35E+01 | 1.13E-04 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | **1.70E-04** |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Groundwater | Dermal | Arsenic (Inorganic) | 1.35E+01 | ug/L | 1.35E-02 | mg/L | 1.35E-02 | 3.57E-07 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 5.35E-07 |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Surface Water | Dermal | Arsenic | 8.63E-01 | ug/L | 8.63E-04 | mg/L | 8.63E-04 | 4.93E-09 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 7.39E-09 |
| | | 1-Methylnaphthalene | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.9E-02 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Air | Inhalation of Particulates | Arsenic (inorganic) | 3.60E+02 | mg/kg | 5.29E-04 | ug/m3 | 5.29E-04 | 1.01E-04 | ug/m3 | 4.3E-03 | $(ug/m^3)^{-1}$ | 4.33E-07 |
| | | | | | | | | | | | **Cancer Risk** | **3.40E-04** |
| Non-Salmon Fish | Ingestion | Arsenic | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 0.00E+00 |
| Large Land Mammals | Ingestion | Arsenic | 1.00E-01 | mg/kg | 5.40E-03 | mg/kg | 5.40E-03 | 2.40305E-08 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 3.60E-08 |
| Small Land Mammals | Ingestion | Arsenic | 1.00E-01 | mg/kg | 1.00E-01 | mg/kg | 1.00E-01 | 3.10E-07 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 4.65E-07 |
| Birds | Ingestion | Arsenic | 1.10E-01 | mg/kg | 1.10E-01 | mg/kg | 1.10E-01 | 1.65E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 2.48E-06 |
| Berries and Plants | Ingestion | Arsenic (Inorganic) | 3.60E+02 | mg/kg | 2.16E+00 | mg/kg | 2.16E+00 | 1.29E-06 | mg/kg-d | 1.5E+00 | $(mg/kg\text{-}d)^{-1}$ | 1.94E-06 |
| | | | | | | | | | | | **Cancer Risk** | 4.92E-06 |

| | |
|---|---|
| **Total Excess Cancer Risk** | **3.45E-04** |

## Table D-16
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Background
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Target Organ | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Soil | Ingestion | Aluminum | 1.96E+04 | mg/kg | 1.96E+04 | mg/kg | 1.96E+04 | 2.07E-02 | 1.93E-01 | mg/kg-d | 1.0E+00 | mg/kg-d | | 2.07E-02 | 1.9E-01 |
| | | Antimony | 8.00E+00 | mg/kg | 8.00E+00 | mg/kg | 8.00E+00 | 8.45E-06 | 7.89E-05 | mg/kg-d | 4.0E-04 | mg/kg-d | | 2.11E-02 | 2.0E-01 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 2.28E-04 | 2.13E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | | 7.60E-01 | **7.1E+00** |
| | | Barium | 2.38E+02 | mg/kg | 2.38E+02 | mg/kg | 2.38E+02 | 2.51E-04 | 2.34E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | | 1.25E-03 | 1.2E-02 |
| | | Chromium | 2.87E+01 | mg/kg | 2.87E+01 | mg/kg | 2.87E+01 | 3.04E-05 | 2.83E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | | 2.02E-05 | 1.9E-04 |
| | | Cobalt | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+01 | 1.20E-05 | 1.12E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | 4.00E-02 | 3.7E-01 |
| | | Iron | 3.10E+04 | mg/kg | 3.10E+04 | mg/kg | 3.10E+04 | 3.28E-02 | 3.06E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | | 4.69E-02 | 4.4E-01 |
| | | Manganese | 8.16E+02 | mg/kg | 8.16E+02 | mg/kg | 8.16E+02 | 8.62E-04 | 8.05E-03 | mg/kg-d | 2.4E-02 | mg/kg-d | | 3.59E-02 | 3.4E-01 |
| | | Mercury | 1.86E+00 | mg/kg | 1.86E+00 | mg/kg | 1.86E+00 | 1.97E-06 | 1.83E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 6.55E-03 | 6.1E-02 |
| | | Thallium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 5.83E+01 | mg/kg | 5.83E+01 | mg/kg | 5.83E+01 | 6.17E-05 | 5.75E-04 | mg/kg-d | 5.0E-03 | mg/kg-d | | 1.23E-02 | 1.2E-01 |
| | | | | | | | | | | | | | **Hazard Index** | 9.45E-01 | **8.82E+00** |
| Soil | Dermal | Aluminum | 1.96E+04 | mg/kg | 1.96E+04 | mg/kg | 1.96E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Antimony | 8.00E+00 | mg/kg | 8.00E+00 | mg/kg | 8.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 3.60E+02 | mg/kg | 3.60E+02 | mg/kg | 3.60E+02 | 4.55E-05 | 2.98E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | 1.52E-01 | 9.9E-01 |
| | | Barium | 2.38E+02 | mg/kg | 2.38E+02 | mg/kg | 2.38E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Chromium | 2.87E+01 | mg/kg | 2.87E+01 | mg/kg | 2.87E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.14E+01 | mg/kg | 1.14E+01 | mg/kg | 1.14E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Iron | 3.10E+04 | mg/kg | 3.10E+04 | mg/kg | 3.10E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Manganese | 8.16E+02 | mg/kg | 8.16E+02 | mg/kg | 8.16E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Mercury | 1.86E+00 | mg/kg | 1.86E+00 | mg/kg | 1.86E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Thallium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 5.83E+01 | mg/kg | 5.83E+01 | mg/kg | 5.83E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | | **Hazard Index** | 1.52E-01 | 9.93E-01 |
| Sediment | Dermal | Aluminum | 1.36E+04 | mg/kg | 1.36E+04 | mg/kg | 1.36E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Antimony | 3.51E-01 | mg/kg | 3.51E-01 | mg/kg | 3.51E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 6.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 5.28E+01 | mg/kg | 5.28E+01 | mg/kg | 5.28E+01 | 6.68E-06 | 4.37E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 2.23E-02 | 1.5E-01 |
| | | Barium | 1.68E+02 | mg/kg | 1.68E+02 | mg/kg | 1.68E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Cadmium | 5.96E-01 | mg/kg | 5.96E-01 | mg/kg | 5.96E-01 | 2.51E-09 | 1.65E-08 | mg/kg-d | 2.5E-05 | mg/kg-d | | 1.01E-04 | 6.6E-04 |
| | | Chromium | 2.51E+01 | mg/kg | 2.51E+01 | mg/kg | 2.51E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 1.37E+01 | mg/kg | 1.37E+01 | mg/kg | 1.37E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Copper | 3.55E+01 | mg/kg | 3.55E+01 | mg/kg | 3.55E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 4.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Iron | 3.35E+04 | mg/kg | 3.35E+04 | mg/kg | 3.35E+04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Manganese | 9.82E+02 | mg/kg | 9.82E+02 | mg/kg | 9.82E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 9.6E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Mercury | 1.80E-01 | mg/kg | 1.80E-01 | mg/kg | 1.80E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.1E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Methyl Mercury | 2.80E-04 | mg/kg | 2.80E-04 | mg/kg | 2.80E-04 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Nickel | 3.86E+01 | mg/kg | 3.86E+01 | mg/kg | 3.86E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 8.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Selenium | 7.02E-01 | mg/kg | 7.02E-01 | mg/kg | 7.02E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Silver | 1.28E-01 | mg/kg | 1.28E-01 | mg/kg | 1.28E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Thallium | 1.16E-01 | mg/kg | 1.16E-01 | mg/kg | 1.16E-01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 3.61E+01 | mg/kg | 3.61E+01 | mg/kg | 3.61E+01 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Zinc | 1.29E+02 | mg/kg | 1.29E+02 | mg/kg | 1.29E+02 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-01 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | | **Hazard Index** | 2.24E-02 | 1.46E-01 |

## Table D-16
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Background
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Target Organ | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Groundwater | Ingestion | Antimony | 5.05E-01 | ug/L | 5.05E-01 | ug/L | 5.05E-01 | 1.38E-05 | 3.23E-05 | mg/kg-d | 4.0E-04 | mg/kg-d | | 3.46E-02 | 8.1E-02 |
| | | Arsenic | 1.35E+01 | ug/L | 1.35E+01 | ug/L | 1.35E+01 | 3.70E-04 | 8.63E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | **1.23E+00** | **2.9E+00** |
| | | Arsenic (Inorganic) | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Barium | 8.33E+01 | ug/L | 8.33E+01 | ug/L | 8.33E+01 | 2.28E-03 | 5.33E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | | 1.14E-02 | 2.7E-02 |
| | | Chromium | 4.95E+00 | ug/L | 4.95E+00 | ug/L | 4.95E+00 | 1.36E-04 | 3.16E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | | 9.04E-05 | 2.1E-04 |
| | | Cobalt | 1.14E+00 | ug/L | 1.14E+00 | ug/L | 1.14E+00 | 3.12E-05 | 7.29E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 1.04E-01 | 2.4E-01 |
| | | Iron | 8.99E+03 | ug/L | 8.99E+03 | ug/L | 8.99E+03 | 2.46E-01 | 5.75E-01 | mg/kg-d | 7.0E-01 | mg/kg-d | | 3.52E-01 | 8.2E-01 |
| | | Manganese | 1.12E+03 | ug/L | 1.12E+03 | ug/L | 1.12E+03 | 3.07E-02 | 7.16E-02 | mg/kg-d | 2.4E-02 | mg/kg-d | | **1.28E+00** | **3.0E+00** |
| | | Mercury | 5.41E+01 | ug/L | 5.41E+01 | ug/L | 5.41E+01 | 1.48E-03 | 3.46E-03 | mg/kg-d | 3.0E-04 | mg/kg-d | | **4.94E+00** | **1.2E+01** |
| | | Nickel | 2.68E+00 | ug/L | 2.68E+00 | ug/L | 2.68E+00 | 7.34E-05 | 1.71E-04 | mg/kg-d | 2.0E-02 | mg/kg-d | | 3.67E-03 | 8.6E-03 |
| | | Selenium | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Thallium | 9.00E-03 | ug/L | 9.00E-03 | ug/L | 9.00E-03 | 2.47E-07 | 5.75E-07 | mg/kg-d | 1.0E-05 | mg/kg-d | | 2.47E-02 | 5.8E-02 |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | ug/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | | **Hazard Index** | **7.98E+00** | **1.86E+01** |
| Groundwater | Dermal | Antimony | 5.05E-01 | ug/L | 5.05E-04 | mg/L | 5.05E-04 | 3.11E-08 | 7.03E-11 | mg/kg-d | 6.0E-05 | mg/kg-d | | 5.19E-04 | 1.2E-06 |
| | | Arsenic | 1.35E+01 | ug/L | 1.35E-02 | mg/L | 1.35E-02 | 8.32E-07 | 1.88E-06 | mg/kg-d | 3.0E-04 | mg/kg-d | | 2.77E-03 | 6.3E-03 |
| | | Arsenic (Inorganic) | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Barium | 8.33E+01 | ug/L | 8.33E-02 | mg/L | 8.33E-02 | 5.13E-06 | 1.16E-05 | mg/kg-d | 1.4E-02 | mg/kg-d | | 3.67E-04 | 8.3E-04 |
| | | Chromium | 4.95E+00 | ug/L | 4.95E-03 | mg/L | 4.95E-03 | 3.05E-07 | 6.89E-07 | mg/kg-d | 2.0E-02 | mg/kg-d | | 1.53E-05 | 3.4E-05 |
| | | Cobalt | 1.14E+00 | ug/L | 1.14E-03 | mg/L | 1.14E-03 | 2.81E-08 | 6.35E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | | 9.37E-05 | 2.1E-04 |
| | | Iron | 8.99E+03 | ug/L | 8.99E+00 | mg/L | 8.99E+00 | 5.54E-04 | 1.25E-03 | mg/kg-d | 7.0E-01 | mg/kg-d | | 7.92E-04 | 1.8E-03 |
| | | Manganese | 1.12E+03 | ug/L | 1.12E+00 | mg/L | 1.12E+00 | 6.90E-05 | 1.56E-04 | mg/kg-d | 9.6E-04 | mg/kg-d | | 7.19E-02 | 1.6E-01 |
| | | Mercury | 5.41E+01 | ug/L | 5.41E-02 | mg/L | 5.41E-02 | 3.33E-06 | 7.53E-06 | mg/kg-d | 2.1E-05 | mg/kg-d | | 1.59E-01 | 3.6E-01 |
| | | Nickel | 2.68E+00 | ug/L | 2.68E-03 | mg/L | 2.68E-03 | 3.30E-08 | 7.46E-08 | mg/kg-d | 8.0E-04 | mg/kg-d | | 4.13E-05 | 9.3E-05 |
| | | Selenium | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Thallium | 9.00E-03 | ug/L | 9.00E-06 | mg/L | 9.00E-06 | 5.55E-10 | 1.25E-09 | mg/kg-d | 1.0E-05 | mg/kg-d | | 5.55E-05 | 1.3E-04 |
| | | Bis(2-ethylhexyl)phthalate | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | | **Hazard Index** | 2.35E-01 | 5.30E-01 |
| Surface Water | Dermal | Antimony | 1.52E+00 | ug/L | 1.52E-03 | mg/L | 1.52E-03 | 2.02E-08 | 6.91E-08 | mg/kg-d | 6.0E-05 | mg/kg-d | | 3.37E-04 | 1.2E-03 |
| | | Arsenic | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 8.63E-01 | ug/L | 8.63E-04 | mg/L | 8.63E-04 | 1.15E-08 | 3.92E-08 | mg/kg-d | 3.0E-04 | mg/kg-d | | 3.83E-05 | 1.3E-04 |
| | | Cadmium | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.5E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 6.60E-02 | ug/L | 6.60E-05 | mg/L | 6.60E-05 | 3.52E-10 | 1.20E-09 | mg/kg-d | 3.0E-04 | mg/kg-d | | 1.17E-06 | 4.0E-06 |
| | | Copper | 3.70E-01 | ug/L | 3.70E-04 | mg/L | 3.70E-04 | 4.93E-09 | 1.68E-08 | mg/kg-d | 4.0E-02 | mg/kg-d | | 1.23E-07 | 4.2E-07 |
| | | Iron | 1.38E+02 | ug/L | 1.38E-01 | mg/L | 1.38E-01 | 1.84E-06 | 6.28E-06 | mg/kg-d | 7.0E-01 | mg/kg-d | | 2.63E-06 | 9.0E-06 |
| | | Manganese | 1.75E+01 | ug/L | 1.75E-02 | mg/L | 1.75E-02 | 2.33E-07 | 7.96E-07 | mg/kg-d | 9.6E-04 | mg/kg-d | | 2.43E-04 | 8.3E-04 |
| | | Mercury | 2.63E-03 | ug/L | 2.63E-06 | mg/L | 2.63E-06 | 3.50E-11 | 1.20E-10 | mg/kg-d | 2.1E-05 | mg/kg-d | | 1.67E-06 | 5.7E-06 |
| | | Methyl Mercury | 8.00E-05 | ug/L | 8.00E-08 | mg/L | 8.00E-08 | 1.07E-12 | 3.64E-12 | mg/kg-d | 1.0E-04 | mg/kg-d | | 1.07E-08 | 3.6E-08 |
| | | Nickel | 4.40E-01 | ug/L | 4.40E-04 | mg/L | 4.40E-04 | 1.17E-09 | 4.00E-09 | mg/kg-d | 8.0E-04 | mg/kg-d | | 1.47E-06 | 5.0E-06 |
| | | Selenium | 5.00E-01 | ug/L | 5.00E-04 | mg/L | 5.00E-04 | 6.66E-09 | 2.27E-08 | mg/kg-d | 5.0E-03 | mg/kg-d | | 1.33E-06 | 4.5E-06 |
| | | Silver | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Zinc | 5.00E-01 | ug/L | 5.00E-04 | mg/L | 5.00E-04 | 4.00E-09 | 1.36E-08 | mg/kg-d | 3.0E-01 | mg/kg-d | | 1.33E-08 | 4.5E-08 |
| | | 1-Methylnaphthalene | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Naphthalene | 0.00E+00 | ug/L | 0.00E+00 | mg/L | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | | **Hazard Index** | 6.27E-04 | 2.14E-03 |
| | | Aluminum | 1.96E+04 | mg/kg | 2.88E-05 | mg/m3 | 2.88E-05 | 2.13E-05 | 2.13E-05 | mg/m3 | 5.0E-03 | mg/m3 | | 4.26E-03 | 4.3E-03 |
| | | Antimony | 8.00E+00 | mg/kg | 1.18E-08 | mg/m3 | 1.18E-08 | 8.70E-09 | 8.70E-09 | mg/m3 | -- | mg/m3 | | -- | -- |

## Table D-16
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Background
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Target Organ | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Air | Dust Particulates or Volatile from Soil | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/m3 | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/m3 | 1.5E-05 | mg/m3 | | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 3.60E+02 | mg/kg | 5.29E-07 | mg/m3 | 5.29E-07 | 2.35E-07 | 2.35E-07 | mg/m3 | 1.5E-05 | mg/m3 | | 1.56E-02 | 1.6E-02 |
| | | Barium | 2.38E+02 | mg/kg | 3.49E-07 | mg/m3 | 3.49E-07 | 2.58E-07 | 2.58E-07 | mg/m3 | 5.0E-04 | mg/m3 | | 5.17E-04 | 5.2E-04 |
| | | Chromium | 2.87E+01 | mg/kg | 4.23E-08 | mg/m3 | 4.23E-08 | 3.13E-08 | 3.13E-08 | mg/m3 | -- | mg/m3 | | -- | -- |
| | | Cobalt | 1.14E+01 | mg/kg | 1.67E-08 | mg/m3 | 1.67E-08 | 1.24E-08 | 1.24E-08 | mg/m3 | 6.0E-06 | mg/m3 | | 2.06E-03 | 2.1E-03 |
| | | Iron | 3.10E+04 | mg/kg | 4.57E-05 | mg/m3 | 4.57E-05 | 3.38E-05 | 3.38E-05 | mg/m3 | -- | mg/m3 | | -- | -- |
| | | Manganese | 8.16E+02 | mg/kg | 1.20E-06 | mg/m3 | 1.20E-06 | 8.88E-07 | 8.88E-07 | mg/m3 | 5.0E-05 | mg/m3 | | 1.78E-02 | 1.8E-02 |
| | | Mercury | 1.86E+00 | mg/kg | 8.34E-05 | mg/m3 | 8.34E-05 | 6.17E-05 | 6.17E-05 | mg/m3 | 3.0E-04 | mg/m3 | | 2.06E-01 | 2.1E-01 |
| | | Thallium | 0.00E+00 | mg/kg | 0.00E+00 | mg/m3 | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/m3 | -- | mg/m3 | | -- | -- |
| | | Vanadium | 5.83E+01 | mg/kg | 8.58E-08 | mg/m3 | 8.58E-08 | 6.35E-08 | 6.35E-08 | mg/m3 | -- | mg/m3 | | -- | -- |
| | | | | | | | | | | | | | **Hazard Index** | 2.46E-01 | 2.46E-01 |
| Air | Volatile from Groundwater | Mercury | 1.48E+01 | ug/L | 7.39E-03 | mg/m3 | 7.39E-03 | 2.22E-04 | 2.22E-04 | mg/m3 | 3.0E-04 | mg/m3 | | 7.39E-01 | 7.4E-01 |

## Table D-16
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Background
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Target Organ | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Non-Salmon Fish | Ingestion | Aluminum | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E+00 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Antimony | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 4.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic (Inorganic) | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Barium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-01 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Cadmium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Chromium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.5E+00 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Copper | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 4.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Iron | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 7.0E-01 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Manganese | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.4E-01 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Mercury | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Methyl Mercury | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | | mg/kg-d | | | |
| | | Nickel | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 2.0E-02 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Selenium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Silver | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Thallium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 5.0E-03 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Zinc | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-01 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | | | | | | | | | | | | **Hazard Index** | 0.00E+00 | 0.00E+00 |
| Large Land Mammal | Ingestion | Aluminum | 8.70E+00 | mg/kg | 3.52E-01 | mg/kg | 3.52E-01 | 3.82E-04 | 8.55E-04 | mg/kg-d | 1.0E+00 | mg/kg-d | | 3.82E-04 | 8.5E-04 |
| | | Antimony | 1.39E-01 | mg/kg | 3.75E-03 | mg/kg | 3.75E-03 | 4.06E-06 | 9.10E-06 | mg/kg-d | 4.0E-04 | mg/kg-d | | 1.02E-02 | 2.3E-02 |
| | | Arsenic | 1.00E-01 | mg/kg | 5.40E-03 | mg/kg | 5.40E-03 | 5.85E-06 | 1.31E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 1.95E-02 | 4.4E-02 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Barium | 3.40E+01 | mg/kg | 1.38E-01 | mg/kg | 1.38E-01 | 1.49E-04 | 3.34E-04 | mg/kg-d | 2.0E-01 | mg/kg-d | | 7.46E-04 | 1.7E-03 |
| | | Chromium | 1.10E+00 | mg/kg | 1.63E-01 | mg/kg | 1.63E-01 | 1.77E-04 | 3.96E-04 | mg/kg-d | 1.5E+00 | mg/kg-d | | 1.18E-04 | 2.6E-04 |
| | | Cobalt | 7.90E-02 | mg/kg | 4.27E-02 | mg/kg | 4.27E-02 | 4.62E-05 | 1.03E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | 1.54E-01 | 3.4E-01 |
| | | Iron | 2.79E+01 | mg/kg | 1.51E+01 | mg/kg | 1.51E+01 | 1.63E-02 | 3.65E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | | 2.33E-02 | 5.2E-02 |
| | | Manganese | 2.29E+02 | mg/kg | 2.47E+00 | mg/kg | 2.47E+00 | 2.68E-03 | 6.00E-03 | mg/kg-d | 1.4E-01 | mg/kg-d | | 1.91E-02 | 4.3E-02 |
| | | Mercury | 5.60E-02 | mg/kg | 3.78E-01 | mg/kg | 3.78E-01 | 4.09E-04 | 9.17E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | **1.36E+00** | **3.1E+00** |
| | | Thallium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 5.00E-02 | mg/kg | 3.38E-03 | mg/kg | 3.38E-03 | 3.65E-06 | 8.19E-06 | mg/kg-d | 5.0E-03 | mg/kg-d | | 7.31E-04 | 1.6E-03 |
| | | | | | | | | | | | | | **Hazard Index** | **1.59E+00** | **3.57E+00** |
| Small Land Mammal | Ingestion | Aluminum | 8.70E+00 | mg/kg | 8.70E+00 | mg/kg | 8.70E+00 | 4.60E-03 | 1.03E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | | 4.60E-03 | 1.0E-02 |
| | | Antimony | 1.39E-01 | mg/kg | 1.39E-01 | mg/kg | 1.39E-01 | 7.35E-05 | 1.65E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | | 1.84E-01 | 4.1E-01 |
| | | Arsenic | 1.00E-01 | mg/kg | 1.00E-01 | mg/kg | 1.00E-01 | 5.29E-05 | 1.18E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | 1.76E-01 | 3.9E-01 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Barium | 3.40E+01 | mg/kg | 3.40E+01 | mg/kg | 3.40E+01 | 1.80E-02 | 4.03E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | | 8.99E-02 | 2.0E-01 |
| | | Chromium | 1.10E+00 | mg/kg | 1.10E+00 | mg/kg | 1.10E+00 | 5.81E-04 | 1.30E-03 | mg/kg-d | 1.5E+00 | mg/kg-d | | 3.88E-04 | 8.7E-04 |
| | | Cobalt | 7.90E-02 | mg/kg | 7.90E-02 | mg/kg | 7.90E-02 | 4.18E-05 | 9.35E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 1.39E-01 | 3.1E-01 |
| | | Iron | 2.79E+01 | mg/kg | 2.79E+01 | mg/kg | 2.79E+01 | 1.47E-02 | 3.30E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | | 2.11E-02 | 4.7E-02 |
| | | Manganese | 2.29E+02 | mg/kg | 2.29E+02 | mg/kg | 2.29E+02 | 1.21E-01 | 2.71E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | | 8.65E-01 | **1.9E+00** |
| | | Mercury | 5.60E-02 | mg/kg | 5.60E-02 | mg/kg | 5.60E-02 | 2.96E-05 | 6.63E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 9.87E-02 | 2.2E-01 |
| | | Thallium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 5.00E-02 | mg/kg | 5.00E-02 | mg/kg | 5.00E-02 | 2.64E-05 | 5.92E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | | 5.29E-03 | 1.2E-02 |
| | | | | | | | | | | | | | **Hazard Index** | **1.58E+00** | **3.55E+00** |
| | | Aluminum | 6.88E+01 | mg/kg | 6.88E+01 | mg/kg | 6.88E+01 | 1.07E-02 | 2.39E-02 | mg/kg-d | 1.0E+00 | mg/kg-d | | 1.07E-02 | 2.4E-02 |

## Table D-16
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Background
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Target Organ | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Birds | Ingestion | Antimony | 1.49E+00 | mg/kg | 1.49E+00 | mg/kg | 1.49E+00 | 2.31E-04 | 5.18E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | | 5.78E-01 | **1.3E+00** |
| | | Arsenic | 1.10E-01 | mg/kg | 1.10E-01 | mg/kg | 1.10E-01 | 1.71E-05 | 3.83E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 5.69E-02 | 1.3E-01 |
| | | Arsenic (inorganic) | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Barium | 8.04E+01 | mg/kg | 8.04E+01 | mg/kg | 8.04E+01 | 1.25E-02 | 2.80E-02 | mg/kg-d | 2.0E-01 | mg/kg-d | | 6.24E-02 | 1.4E-01 |
| | | Chromium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.5E+00 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Cobalt | 9.40E-02 | mg/kg | 9.40E-02 | mg/kg | 9.40E-02 | 1.46E-05 | 3.27E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 4.87E-02 | 1.1E-01 |
| | | Iron | 2.50E+01 | mg/kg | 2.50E+01 | mg/kg | 2.50E+01 | 3.88E-03 | 8.68E-03 | mg/kg-d | 7.0E-01 | mg/kg-d | | 5.54E-03 | 1.2E-02 |
| | | Manganese | 1.59E+03 | mg/kg | 1.59E+03 | mg/kg | 1.59E+03 | 2.47E-01 | 5.53E-01 | mg/kg-d | 1.4E-01 | mg/kg-d | | **1.76E+00** | **4.0E+00** |
| | | Mercury | 5.60E-02 | mg/kg | 5.60E-02 | mg/kg | 5.60E-02 | 8.70E-06 | 1.95E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 2.90E-02 | 6.5E-02 |
| | | Thallium | 1.50E-02 | mg/kg | 1.50E-02 | mg/kg | 1.50E-02 | 2.33E-06 | 5.22E-06 | mg/kg-d | 1.0E-05 | mg/kg-d | | 2.33E-01 | 5.2E-01 |
| | | Vanadium | 5.00E-02 | mg/kg | 5.00E-02 | mg/kg | 5.00E-02 | 7.76E-06 | 1.74E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | | 1.55E-03 | 3.5E-03 |
| | | | | | | | | | | | | | **Hazard Index** | **2.79E+00** | **6.25E+00** |

## Table D-16
## CALCULATION OF NON-CANCER HAZARDS
## RED DEVIL MINE

Scenario Timeframe: Future
Receptor Population: Residential - Background
Receptor Age: Adult/Child

| Medium | Exposure Route | Contaminant of Potential Concern | Medium EPC Value | Medium EPC Units | Route EPC Value | Route EPC Units | EPC Selected for Risk Calculation | Adult Intake | Child Intake | Intake Units | Chronic Reference Dose | Chronic Reference Dose Units | Target Organ | Adult Hazard Quotient | Child Hazard Quotient |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Berries and Plants | Ingestion | Aluminum | 1.96E+04 | mg/kg | 1.27E+01 | mg/kg | 1.27E+01 | 2.60E-03 | 5.82E-03 | mg/kg-d | 1.0E+00 | mg/kg-d | | 2.60E-03 | 5.8E-03 |
| | | Antimony | 8.00E+00 | mg/kg | 2.40E-01 | mg/kg | 2.40E-01 | 4.90E-05 | 1.10E-04 | mg/kg-d | 4.0E-04 | mg/kg-d | | 1.23E-01 | 2.7E-01 |
| | | Arsenic | | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 3.0E-04 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Arsenic (inorganic) | 3.60E+02 | mg/kg | 2.16E+00 | mg/kg | 2.16E+00 | 4.41E-04 | 9.87E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | **1.47E+00** | **3.3E+00** |
| | | Barium | 2.38E+02 | mg/kg | 3.56E+00 | mg/kg | 3.56E+00 | 7.28E-04 | 1.63E-03 | mg/kg-d | 2.0E-01 | mg/kg-d | | 3.64E-03 | 8.2E-03 |
| | | Chromium | 2.87E+01 | mg/kg | 1.29E-01 | mg/kg | 1.29E-01 | 2.64E-05 | 5.92E-05 | mg/kg-d | 1.5E+00 | mg/kg-d | | 1.76E-05 | 3.9E-05 |
| | | Cobalt | 1.14E+01 | mg/kg | 7.95E-02 | mg/kg | 7.95E-02 | 1.62E-05 | 3.64E-05 | mg/kg-d | 3.0E-04 | mg/kg-d | | 5.41E-02 | 1.2E-01 |
| | | Iron | 3.10E+04 | mg/kg | 3.10E+01 | mg/kg | 3.10E+01 | 6.34E-03 | 1.42E-02 | mg/kg-d | 7.0E-01 | mg/kg-d | | 9.06E-03 | 2.0E-02 |
| | | Manganese | 8.16E+02 | mg/kg | 4.08E+01 | mg/kg | 4.08E+01 | 8.33E-03 | 1.87E-02 | mg/kg-d | 1.4E-01 | mg/kg-d | | 5.95E-02 | 1.3E-01 |
| | | Mercury | 1.86E+00 | mg/kg | 3.72E-01 | mg/kg | 3.72E-01 | 7.60E-05 | 1.70E-04 | mg/kg-d | 3.0E-04 | mg/kg-d | | 2.53E-01 | 5.7E-01 |
| | | Thallium | 0.00E+00 | mg/kg | 0.00E+00 | mg/kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | mg/kg-d | 1.0E-05 | mg/kg-d | | 0.00E+00 | 0.0E+00 |
| | | Vanadium | 5.83E+01 | mg/kg | 1.75E-01 | mg/kg | 1.75E-01 | 3.58E-05 | 8.01E-05 | mg/kg-d | 5.0E-03 | mg/kg-d | | 7.15E-03 | 1.6E-02 |
| | | | | | | | | | | | | | **Hazard Index** | **1.98E+00** | **4.44E+00** |

| | | |
|---|---|---|
| **Total Hazard Index** | **1.75E+01** | **4.72E+01** |

## Table D-17
## PARTICULATE EMISSION FACTOR FOR UNPAVED ROAD TRAFFIC

$$F_D = 0.1852 + \frac{5.3537}{t} + \frac{-9.6318}{t^2}$$

| | | | |
|---|---|---|---|
| t = | 720 | hr | (90 days x 8 hr/day) |
| $F_D$ = | 0.192 | (unitless) | |

$$PEF_{sr} = Q/C_{sr} \times \frac{1}{F_D} \times \frac{T \times A_R}{\frac{2.6 \times (s/12)^{0.8} (W/3)^{0.4}}{(M_{dry}/0.2)^{0.3}} \times \frac{365-p}{365} \times 281.9 \times \sum VKT}$$

| | | | |
|---|---|---|---|
| $Q/C_{sr}$ = | 46.92 | $g/m^2$-s per $kg/m^3$ | Default for Minneapolis, MN largest source area |
| T = | 2,592,000 | s | (90 days x 8 hr/day x 3600 s/hr) |
| $A_R$ = | 995,000 | $m^2$ | 246 acres |
| s = | 8.5 | % | (default) |
| W = | 0.277 | Ton | vehicle = 181 kg (yamaha-moter.com, based on 400 lb ATV) +70 kg rider |
| $M_{dry}$ = | 0.20 | % | (default) |
| ∑VKT = | 1.08E+03 | km | (10 vehicles x 1.2 km/day [2x site width] x 90 days) |
| p = | 49 | days | (sum of precipitation data from Bethel, AK - summer months) |
| PEF = | 3.14E+09 | $m^3/kg$ | |

Reference:
EPA 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites.
OSWER 9355.4-24. December

# E Lead Model

LEAD MODEL FOR WINDOWS Version 1.1

==========================================================================

Model Version: 1.1 Build11
User Name:
Date:
Site Name:
Operable Unit:
Run Mode: Research

==========================================================================

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

| Age | Time Outdoors (hours) | Ventilation Rate ($m^3$/day) | Lung Absorption (%) | Outdoor Air Pb Conc (µg Pb/$m^3$) |
|---|---|---|---|---|
| .5-1 | 1.000 | 2.000 | 32.000 | 0.100 |
| 1-2 | 2.000 | 3.000 | 32.000 | 0.100 |
| 2-3 | 3.000 | 5.000 | 32.000 | 0.100 |
| 3-4 | 4.000 | 5.000 | 32.000 | 0.100 |
| 4-5 | 4.000 | 5.000 | 32.000 | 0.100 |
| 5-6 | 4.000 | 7.000 | 32.000 | 0.100 |
| 6-7 | 4.000 | 7.000 | 32.000 | 0.100 |

****** Diet ******

| Age | Diet Intake(µg/day) |
|---|---|
| .5-1 | 5.299 |
| 1-2 | 5.353 |
| 2-3 | 5.942 |
| 3-4 | 5.925 |
| 4-5 | 5.918 |
| 5-6 | 6.296 |
| 6-7 | 7.030 |

Alternative Dietary Values
Home grown fruits concentration: 1.610 µg/g
Home grown vegetables concentration: 0.000 µg/g
Fish from fishing concentration: 0.037 µg/g
Game animals from hunting concentration: 0.111 µg/g
*Home grown fruits factor: 2.000 % of all fruits*
Home grown vegetables factor: 0.000 % of all vegetables
Fish from fishing factor: 70.000 %of all meat
Game animals from hunting factor: 30.000 % of all meat

****** Drinking Water ******

Water Consumption:

| Age | Water (L/day) |
|---|---|
| .5-1 | 0.200 |
| 1-2 | 0.500 |
| 2-3 | 0.520 |
| 3-4 | 0.530 |
| 4-5 | 0.550 |
| 5-6 | 0.580 |
| 6-7 | 0.590 |

Drinking Water Concentration: 0.370 µg Pb/L

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 38.959 µg/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

| Age | Soil (µg Pb/g) | House Dust (µg Pb/g) |
|---|---|---|
| .5-1 | 41.370 | 38.959 |
| 1-2 | 41.370 | 38.959 |
| 2-3 | 41.370 | 38.959 |
| 3-4 | 41.370 | 38.959 |
| 4-5 | 41.370 | 38.959 |
| 5-6 | 41.370 | 38.959 |
| 6-7 | 41.370 | 38.959 |

****** Alternate Intake ******

| Age | Alternate (µg Pb/day) |
|---|---|
| .5-1 | 0.000 |
| 1-2 | 0.000 |
| 2-3 | 0.000 |
| 3-4 | 0.000 |
| 4-5 | 0.000 |
| 5-6 | 0.000 |
| 6-7 | 0.000 |

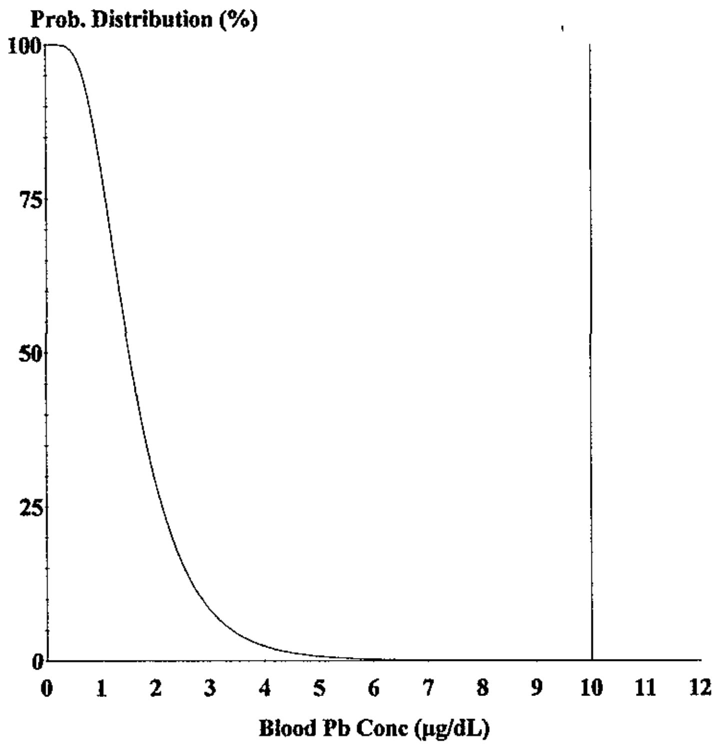
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 1.000 µg Pb/dL

******************************************
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
******************************************

| Year | Air (µg/day) | Diet (µg/day) | Alternate (µg/day) | Water (µg/day) |
|---|---|---|---|---|
| .5-1 | 0.021 | 2.545 | 0.000 | 0.036 |
| 1-2 | 0.034 | 2.580 | 0.000 | 0.089 |
| 2-3 | 0.062 | 2.873 | 0.000 | 0.093 |
| 3-4 | 0.067 | 2.879 | 0.000 | 0.095 |
| 4-5 | 0.067 | 2.892 | 0.000 | 0.099 |
| 5-6 | 0.093 | 3.084 | 0.000 | 0.105 |
| 6-7 | 0.093 | 3.445 | 0.000 | 0.107 |

| Year | Soil+Dust (µg/day) | Total (µg/day) | Blood (µg/dL) |
|---|---|---|---|
| .5-1 | 0.981 | 3.582 | 2.0 |
| 1-2 | 1.563 | 4.266 | 1.8 |
| 2-3 | 1.568 | 4.596 | 1.7 |
| 3-4 | 1.576 | 4.616 | 1.6 |
| 4-5 | 1.174 | 4.233 | 1.5 |
| 5-6 | 1.059 | 4.342 | 1.3 |
| 6-7 | 1.001 | 4.646 | 1.3 |




Cutoff = 10.000 µg/dl
Geo Mean = 1.596
GSD = 1.600
% Above = 0.005

Age Range = 0 to 84 months

Run Mode = Research

# F

# Screening Level Ecological Risk Assessment for the Red Devil Mine Site

**EPA Comments on**

**The Screening Level Ecological Risk Assessment for the Red Devil Mine Site (2-6-12) and**

**E&E Responses to EPA Comments (March 2012)**

Specific Comments:

1. P. 1, 2nd parg. Executive Summary. The text "chemicals were retained for evaluation in the BERA if the screening-level HQ exceeded 1" should be modified to read "if the screening-level HQ was greater than or equal to 1" (i.e. HQ $\geq$ 1) to be consistent with EPA risk assessment policy. This does not appear to have had any effect on the COPECs identified in the SLERA (for example, cobalt in sediment had a HQ = 1.0, but was correctly identified as a COPEC). Similar language appears several other locations in the SLERA (e.g. Section 4.5.2, page 11), and should be corrected throughout the SLERA.

**Response:** The text will be revised accordingly.

2. Executive Summary, Table ES-1. While providing a good overall summary of the findings of the SLERA, Table ES-1 could be made much more useful to risk assessors and risk managers reading the document with the following changes. Instead of using an 'X' to identify the chemicals of potential ecological concern (COPEC's) in the SLERA, enter the maximum identified hazard quotient responsible for identifying the chemical as a COPEC in each medium or receptor. Also, where applicable, list the number of samples out of the total number of samples where the hazard quotient was greater than or equal to one. By preparing the summary table in this manner, it informs the reader of both the magnitude of potential risk, as well as giving a sense of the spatial extent of the risk. This information, in addition to the mere listing of COPECs by receptor or medium, will quickly allow the reader to identify the chemicals with both the greatest potential for risk, as well as the chemicals potentially posing risk across the largest proportion of the site, as opposed to chemicals with both a low magnitude and incidence of potential risk. Chemicals without screening level benchmarks that are passed forward into the BERA should continue to be identified as they are in Table ES-1. These comments also apply to Table 4-26, which is identical to Table ES-1.

**Response:** The tables will be improved as suggested.

3. P. 4, Sect. 2.4. Are wood frogs (*Rana sylvatica*) resident in the vicinity of the site? If they are, this appears to be the only major taxon not evaluated in the SLERA, and should be added as a target ecological receptor if present. If not present, add a sentence confirming the absence of any amphibian and reptile species at the site.

**Response:** It is unknown if wood frogs are present at the site. Amphibians (aquatic stages) are included in *the Fish and Other Aquatic Biota* assessment endpoint listed in Table 3-1and were evaluated by comparing surface water chemical concentrations to water quality criteria. Table 3-1 will be revised to make clear that amphibians are included under this assessment endpoint. Also, Section 4.4 will be revised to be clear that other aquatic organism besides fish are being evaluated.

4. Table 3-1. Comparison of surface water chemical concentrations with water quality criteria is also an applicable measure and analysis approach for benthic invertebrates, as it is for amphibians (wood frog, assuming they are present in the vicinity of the site), and should be listed as such in Table 3-1.

**Response:** We agree with the observation that benthic macroinvertebrates and amphibians are exposed to surface water. Both groups of receptors are implicitly included in the *Fish and Other Aquatic Biota* assessment endpoint. Table 3-1 will be revised to make clear that benthic invertebrates and amphibians are included under this assessment endpoint. Also, Section 4.4 also will be revised to be clear that other aquatic organism besides fish are being evaluated.

5. P. 7, Sect. 3.1.6. At a minimum, identify the tables in the cited documents from which the data used in the

SLERA was taken. Better yet, append the data tables themselves to the SLERA, along with maps or figures of where the samples used in the SLERA were collected. Sampling location figures will help identify areas to be evaluated and sampled during development of the problem formulation and analysis plan of the BERA. This will help address a specific Agency concern, the determination of the contribution of contaminants from Red Devil Creek to organisms in the area of the confluence of the creek with the Kuskokwim River.

**Response:** The revised SLERA will identify the RI report tables that present the data used in the SLERA. We will do the same regarding the BLM data for fish and benthic macroinvertebrates if draft reports are available from BLM at the time the revised SLERA is released.

6. Table 4-1. Two corrections need to be made to this table when identifying the rationale for selecting chemicals as COPECs. For plants, correct the rationale for selecting vanadium as a COPEC from NSL (no screening level available) to >SL (maximum detected concentration exceeds screening level). For soil invertebrates, correct the rationale for selecting mercury as a COPEC from NSL (no screening level available) to >SL (maximum detected concentration exceeds screening level). The text in Sections 4.1 and 4.2 correctly reflect the COPEC calculations and identification, only the rationales in Table 4-1 need correction.

**Response:** The requested corrections will be made.

7. Tables 4-1, 4-2 and 4-3. All three of these tables would be greatly improved by addition of a column tabulating the number of stations where hazard quotients ≥ 1.0 were found, along the lines of the frequency of detection column already present in these tables.

**Response:** The tables will be modified as suggested.

8. P. 8, Sect. 4.4. EPA finds it curious that at a former mercury mine location where mercury is considered to be one of the primary site related contaminants (Sections 2.1 and 3.1.2) that mercury is not identified as a COPEC in surface water or to fish. We believe this is due to use of an insufficiently conservative screening level benchmark for mercury in surface water. The screening value used for total mercury, 0.77 µg/L, derives from EPA's criterion continuous concentration (CCC) aquatic life criteria for freshwater. However, EPA's mercury aquatic life criteria, in its *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water* (EPA-820-B-96-001, September 1996) also states that the mercury CCC might not adequately protect such important fishes as the rainbow trout, Coho salmon and bluegill. The 1995 updates also provide the rationale for this conclusion. Because Coho salmon are known to be present in the Kuskokwim River, and to be adequately protective of Coho and other sensitive species, EPA requires the use of the published EPA 0.012 µg/L mercury criterion as the screening level benchmark value in the Red Devil Mine SLERA. Use of the 0.012 µg/L screening level benchmark results in a maximum surface water HQ = 32, and identifies mercury as a COPEC at the conclusion of the SLERA. Although not screened in the SLERA, measured tissue mercury concentrations in sculpin from the site (SLERA Table 4-6) are well in excess of published ecological risk screening level benchmarks for mercury in fish tissue, which range between 0.06 – 0.20 µg/g whole body, wet weight (Beckvar et al. 2005, Dyer et al. 2000, Shephard 1998). Recent literature reviews of mercury fish tissue residue effects on fish themselves are also available for use in the BERA (e.g. Sandheinrich and Wiener 2011, Dillon et al. 2010). Failure to identify mercury in surface water and fish tissues as a COPEC is the largest single shortcoming in the SLERA, and must be corrected going forward into the BERA. This will require modification to the text in Section 4.4, and to Tables ES-1 and 4-3.

Beckvar, N., T.M. Dillon and L.B. Read. 2005. Approaches for linking whole-body fish tissue residues of mercury or DDT to biological effect thresholds. Environ. Toxicol. Chem. 24:2094-2105.

Dillon, T., N. Beckvar and J. Kern. 2010. Residue-based mercury dose-response in fish: An analysis using lethality-equivalent test endpoints. Environ. Toxicol. Chem. 29:2559-2565.

Dyer, S.D., C.E. White-Hull and B.K. Shephard. 2000. Assessments of chemical mixtures via toxicity reference values over predict hazard to Ohio fish communities. Environ. Sci. Technol. 34:2518-2524.

Sandheinrich, M.B. and J.G. Wiener. 2011. Methylmercury in Freshwater Fish: Recent Advances in Assessing Toxicity of Environmentally Relevant Exposures. pp. 168-190 in Beyer, W.N and J.P. Meador. Environmental Contaminants in Biota. Interpreting Tissue Concentrations, 2nd edition. CRC Press, Boca Raton, FL. 751 pp.

Shephard, B.K. 1998. Quantification of Ecological Risks to Aquatic Biota from Bioaccumulated Chemicals. p. 2-31 to 2-52 in National Sediment Bioaccumulation Conference Proceedings, EPA 823-R-98-002, Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

**Response:** The 0.012 µg/L criterion will be added to the SLERA as a surface water screening level for mercury. As suggested, a second measure to evaluate potential risks to fish will be included in the SLERA and BERA.

9. Table 4-3. The rationale for excluding methylmercury as a COPEC given in the table should be corrected from NSL (no screening level available) to <SL (maximum detected concentration less than screening level). EPA is not surprised at this result, as a very low proportion of total mercury present in surface water is normally present in the form of methylmercury.

**Response:** Table 4-3 will be revised accordingly.

10. Table 4-3. Alkalinity should not be identified as a COPC in surface water. The rationale for EPA's alkalinity criterion is that it reflects a minimum level of alkalinity to be present in surface water (unless naturally occurring alkalinity <20 mg/L as $CaCO_3$), not a maximum level. As all detected alkalinity concentrations exceed 20 mg/L as $CaCO_3$, there is no need to carry alkalinity forward into the BERA. Although this explanation of the alkalinity criterion is not discussed in EPA's current compilations of water quality criteria, it is given in older water quality criteria compendia, such as EPA's Red Book and Gold Book.

**Response:** The oversight will be corrected.

11. P. 9, Sect. 4.5.1.3. The literature models used to estimate chemical concentrations in prey of terrestrial wildlife species feeding on soil invertebrates or mammals are the same models used in the exposure point concentration section of the human health risk assessment for the Red Devil Mine site. Those modeling approaches were reviewed as part of EPA's review of the HHRA, were deemed acceptable for use in the HHRA, and are equally appropriate for use in the SLERA.

**Response:** Agreed.

12. Table 4-8. Any reason surface water ingestion was not included in the ingested contaminant dose estimates for green-winged teal, whereas it is included in the ingested dose calculations for all other bird and mammal species? Teal also drink water. The inclusion of surface water ingestion as part of the bird and mammal ingested dose calculation should also be identified as a complete exposure pathway in the conceptual site model, Figure 3-1. If surface water ingestion is not a complete exposure pathway, it would not need to be included in the ingested dose calculations. In this regard, the ingested dose calculations and conceptual site model are contradictory with respect to surface water ingestion. The contradiction should be corrected by denoting surface water ingestion as a complete pathway for birds and mammals.

**Response:** No surface water was present in the settling ponds during sampling activities at the site. Hence, only sediment (dry) and pond vegetation were collected for the teal scenario. To remedy this data gap, E & E will use surface water data from Red Devil Creek as a surrogate for settling pond surface water.

In the ecological conceptual site model figure, the dash (–) symbol means incomplete or insignificant pathway. The latter meaning is applicable to surface water ingestion for wildlife. The wildlife exposure estimates illustrate this point (see SLERA Tables 4-15 to 4-24); example calculations are provided in the table below.

Examples Showing the Relative Importance of Different Exposure Routes to Total Exposure for Wildlife

| Exposure Route | Exposure (mg/kg-day) | Percent of Total Exposure |
|---|---|---|
| Robin – Antimony (see Table 4-15) | | |
| EE-water | 2.6E-02 | 0.0005% |
| EE-soil | 5.8E+01 | 1% |
| EE-diet | 5.6E+03 | 99% |
| EE-total | 5.7E+03 | 100% |
| Spruce Grouse – Mercury (see Table 4-17) | | |
| EE-water | 2.8E-05 | 0.0002% |
| EE-soil | 1.7E+01 | 96% |
| EE-diet | 6.4E-01 | 4% |
| EE-total | 1.8E+01 | 100% |
| Common Snipe – Arsenic (see Table 4-21) | | |
| EE-water | 1.24E-01 | 0.0067% |
| EE-sediment | 1.79E+03 | 97% |
| EE-diet | 5.11E+01 | 3% |
| EE-total | 1.84E+03 | 100% |

Key:

EE-diet = estimated chemical exposure from diet

EE-sediment = estimated exposure from incidental sediment ingestion

EE-soil = estimated chemical exposure from incidental soil ingestion

EE-total = total chemical exposure

EE-water = estimated chemical exposure from surface water consumption

For the examples given above, surface water exposure accounts for much less than 1% of total chemical exposure. The legend in Figure 3-1 will be revised to clarify the meaning of the dash (–) symbol.

13. P. 11, Sect. 4.5.2 and Table 4-25. Is there a reason, other than lack of data, that mink were not screened against polychlorinated biphenyl (PCB) concentrations and/or ingestion? PCB toxicity data with mink is the basis for mammalian toxicity reference values for PCBs in the ecological risk literature, as it is the most sensitive mammal tested to date. If possible, PCB risks should be screened, or if that is not feasible given the available data, carried forward as a COPEC into the BERA.

**Response:** PCB data were not collected for sediment, surface water, and fish in Red Devil Creek because PCBs are not expected to be present in the creek based on past site uses. For the RI, it was agreed to by all parties that PCBs would be measured in soil from the area were electrical transformers were used and stored. Eighteen soil samples were collected from this area. No PCBs were detected in 17 of the samples. Aroclor 1260 was detected in one sample at 21 parts per trillion (0.021 µg/kg), well below a level of concern for the terrestrial ecological receptors evaluated in the SLERA, including mammalian wildlife (i.e., NOAEL-based HQs for terrestrial mammalian wildlife were several orders of magnitude < 1). The mammalian NOAEL for PCBs used in the SLERA was derived from a study with mink. Given these results and prior agreements between the agencies, we do not see a compelling reason to evaluate PCBs in Red Devil Creek and/or carry PCBs forward into the BERA.

14. P. 12, Sect. 5. Several uncertainties in the SLERA are not discussed, and warrant a brief discussion. These include:

- Area and seasonal use factors (values of 1 used in the SLERA likely overestimate risks)
- Sediment, surface water screening benchmark uncertainties and reliability
- Chemicals without screening level benchmarks (potential underestimation of risks)

**Response:** These uncertainties will be described in the *Uncertainties* section in the revised SLERA.

15. P. 13, Sect. 6. The EPA 8-step ecological risk assessment process calls for a scientific management decision point (SMDP) at the end of Step 2 (completion of the SLERA). Has there already been a decision made to go forward into a BERA? If so, has the risk manager for the site documented this decision? If the decision has not been made to go forward into a BERA, have the risk assessors made recommendations to the risk managers on how to proceed? Tables ES-1 and 4-26 both document which contaminants and pathways can be eliminated from further assessment. Based on the results of the SLERA, the risk manager and risk assessor will determine whether or not contaminants from the site pose an ecological threat that warrants additional assessment, or whether there is adequate information to conclude that ecological risks are negligible and therefore no need for remediation on the basis of ecological risk. This decision needs to be documented, either in a brief SMDP or risk management section of the BERA, or in a separate document outside of the SLERA.

**Response:** BLM has directed E & E to prepare a BERA for the site. This decision will be documented in the BERA. Given the results of the SLERA, we assume that EPA agrees that a BERA is warranted.

**REVISED**
**Screening Level Ecological Risk Assessment for the Red Devil Mine Site**
**Prepared by Ecology and Environment, Inc., Seattle, WA**
**For**
**Bureau of Land Management, Anchorage Field Office, Anchorage, AK**
**April 2012**

# 1 Introduction

This report presents a Screening Level Ecological Risk Assessment (SLERA)1 for the Red Devil Mine (RDM) site. The SLERA consists of Steps 1 and 2 of the eight-step ecological risk assessment (ERA) process described in *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997). The SLERA also is consistent with other notable federal and state ERA guidance documents, including:

- *Guidelines for Ecological Risk Assessment* (EPA 1998)
- *Wildlife Exposure Factors Handbook* (EPA 1993a)
- *Guidance for Developing Ecological Soil Screening Levels* (EPA 2005a)
- *Risk Assessment Procedures Manual* (Alaska DEC 2011)

In addition to the above mentioned state and federal guidance documents, this assessment also utilizes publications from Oak Ridge National Laboratory (ORNL) and recent articles from relevant peer-reviewed literature, as appropriate. The goal of the SLERA is to determine whether risks from site-related chemicals are great enough to warrant further evaluation and, if so, identify chemicals that should be carried forward in the ERA process.

The remainder of this report is organized as follows:

Section 2 describes the site and its ecological resources;

- Section 3 presents a screening-level problem formulation and ecological effects evaluation (ERAGS Step 1).
- Section 4 presents screening-level exposure estimates and risks calculations (ERAGS Step 2).
- Section 5 identifies and discusses sources of uncertainty in the SLERA.
- Section 6 presents a summary.

1 An acronyms list for this appendix is provided in Section 8.

# 2 Site Location and Description

## 2.1 Site Overview

The RDM site is an abandoned mercury mine and ore processing site on the south bank of the Kuskokwim River in a remote area of Alaska, approximately 250 air miles west of Anchorage. The RDM site is located on public land managed by the United States Department of the Interior Bureau of Land Management (BLM) and consists of four main areas: surface mined area, main processing area, Red Devil Creek area, and Kuskokwim River area. A detailed description of the site and its operational history is provided in the RDM Remedial Investigation/Feasibility Study (RI/FS) Work Plan (E & E 2011). This report focuses on the habitats and ecological characteristics of the RDM site. The information provided below is based on earlier site reports (HLA/Wilder 2001) and observations made by E & E and BLM personnel during field activities at the site in 2010 (BLM 2010; E & E 2010).

## 2.2 Climate

The RDM site is located in the upper Kuskokwim River Basin and lies in a climatic transition between the continental zone of Alaska's interior and the maritime zone of the coastal regions. Average temperatures in this area can vary from −7 to 65 °F (−22 to 18 °C). Annual snowfall averages 56 inches (142 centimeters [cm]), with a total mean annual precipitation of 18.8 inches (48 cm). The Kuskokwim River is ice-free from mid-June through October.

## 2.3 Vegetation

The vegetation around the RDM site is characterized by spruce-poplar forests and upland spruce-hardwood forests. During the 2010 sampling season, vegetation characteristics were recorded at surface soil sample locations. E & E field personnel documented the following percent cover of vegetation in each of three layers, or strata: (1) trees (woody vegetation with diameter at breast height [DBH] > 3 inches and over 15 feet tall); (2) samplings/shrubs (woody vegetation with DBH < 3 inches); and (3) herbs (non-woody vegetation). Trees observed included Sitka alder (*Alnus sinuata*), black cottonwood (*Populus trichocarpa Torr. & Gray*), quaking aspen (*Populus tremuloides*), and willow (*Salix sp.*). Saplings and shrubs observed included Sitka alder, black cottonwood, and willow. The dominant species in the herb strata included horsetail (*Equisetum sp.*), various grasses (*Poa sp.* and other unidentified species), ferns (*Athyrium sp.*), various weedy plants (e.g., *Epilobium sp.*), and moss.

Vegetative cover in the main processing area was limited, often consisting of only moss and occasional patches of grass. Cover in this area ranged widely, from 0 to 90 %, represented almost entirely by moss. If moss were removed from this category, vegetative cover would likely be less than 10%. These areas offer limited soils and were heavily compacted in locations subjected to vehicular travel; a majority of the surface material consisted of rock. On the perimeter of the disturbed areas, such as around the processing areas, on the sides of the roads, and along the slopes leading to the creek, saplings were more prevalent, making up 15 to 100 % of vegetative cover. Sitka alder and black cottonwood were the prevalent species occurring in these areas. In areas that showed no sign of disturbance in recent years, vegetation cover was dominated by trees (between 10 and 75 %) and saplings (between 20 and 100%).

The area of Red Devil Creek north of the main processing area, between the two roads, and in the vicinity of settling ponds 2 and 3, was dominated by Sitka alder and black cottonwood trees and saplings, with ferns, grasses, and horsetail in the lower strata. Settling pond 1 was dominated by horsetails.

In general, the disturbed surface mined area of the RDM site had a thick growth of saplings and trees with moderate understory coverage. Vegetation in the upper strata consisted largely of Sitka alder saplings and trees, with black cottonwood and occasional quaking aspen trees. The herb layer in this area was dominated by ferns, grasses, and weedy plants. The vegetation in the Dolly Sluice and Rice Sluice areas was similar in nature, and neither appeared to have any stressed vegetation. The vegetation did not consist of any large alder trees in the channel area of either sluice.

## 2.4 Red Devil Creek and Kuskokwim River Biota

### 2.4.1 Red Devil Creek

Red Devil Creek runs through the middle of the main processing area and discharges to the Kuskokwim River. A historical bridge, now collapsed, crossed the creek and connected the two sides of the main processing area. In the vicinity of the former bridge location, large piles of tailings and/or waste rock make up the creek banks. The creek contains some metal and other debris, likely from past mining activities. During field work in fall 2010, the creek's discharge was visually estimated to be between 2 and 7 cubic feet per minute upstream from the main processing area. Near its confluence with the Kuskokwim River, the creek's discharge was visually estimated to be 15 to 20 cubic feet per minute. Water depth in the creek varied from 3 to 12 inches at locations where surface water and sediment were sampled in fall 2010. Current velocity appeared to decrease upstream of the main processing area, and pool/riffle structure was more frequently observed in addition to woody material.

In 2010, BLM staff collected fish from Red Devil Creek for contaminant analysis (BLM 2010). Slimy sculpin (*Cottus cognatus*, 6 to 9 cm length); juvenile Dolly Varden (11 to 17 cm length); and juvenile salmon (8 to 11 cm length) were collected for analysis. BLM staff found no large game fish in Red Devil Creek, likely due to the creek's shallow depth and narrow width. Also in 2010, BLM staff collected composite samples of two different mayfly genera—*Baetis* spp. and *Cinygmula* spp.—from the creek. *Baetis* spp. and *Cinygmula* spp. are small mayfly species, requiring the BLM to include several hundred individual organisms in each 1-gram composite sample. In fall 2010, the E & E field team that collected sediment from the creek reported seeing numerous small benthic invertebrates and their casings on the undersides of rocks throughout the creek. The small benthic invertebrates observed by the E & E field team likely were mayfly larvae. The E & E field team also observed other benthic invertebrates, including midge (Family Chironomidae) and cranefly (Family Tipulidae) larvae, during sediment sampling. Lastly, the E & E field team reported that moss and brown algae were present in the creek and generally appeared to trend toward increased coverage as sample locations progressed up the reach, but that moss and algae were not present at all sample locations.

### 2.4.2 Kuskokwim River

The Kuskokwim River is a major anadromous fish stream (HLA/Wilder 2001). Fish found in the river in the vicinity of RDM site include whitefish (*Coregonus sp.*), Arctic grayling (*Thymallus arcticus*), sheefish (*Stendous leucichthys nelma*), Dolly Varden (*Salvelinus malma*), burbot (*Lota lota*) and northern pike (*Esox lucius*), as well as chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*), and chum salmon (*O. keta*) (HLA/Wilder 2001; BLM 2010).

## 2.5 Mammals

Moose (*Alces alces*), wolves (*Canis lupis*), black bears (*Ursus americanus*), brown bears (*Ursus arctos*), lynx (*Lynx canadensis*), martens (*Martes spp*.), foxes (*Vulpes vulpes*), beavers (*Castor canadensis*), minks (*Neovision vison*), muskrats (*Ondatra zibenthicus*), otters (*Lutra canadensis*), and various small rodents are known to occur in the area (HSA/Wilder 2001). During field activities in September 2010, three river otters (*Lontra canadensis*) were observed in the Kuskokwim River near the mouth of Red Devil Creek. In addition, moose and bear (*Ursus sp.*) tracks were observed near the upper pond, and bear tracks were also observed near the mouth of Red Devil Creek.

## 2.6 Birds

The upper Kuskowkim River is a low density waterfowl area (HLA/Wilder 2001). Nonetheless, according to Alaska DEC staff, there have been reports of waterfowl (species not specified) using the settling ponds near the main processing area. Songbird species that migrate through the area include the olive-sided flycatcher (*Contopus cooperi*), gray-cheeked thrush (*Catharus minimus*), Townsend’s warbler (*Dendroica townsendi*), blackpoll warbler (*D. striata*), and Hudsonian godwit (*Limosa haemastica*) (HLA/Wilder 2001). A raptor survey conducted on the Kuskokwim River in July 2000 found an active peregrine falcon (*Falco peregrinus*) nest 7 miles downstream from the RDM, on rock cliffs on the north side of the river (BLM 2001). Finally, during field work in September 2010, many spruce grouse (*Dendragapus canadensis*) were observed on and near the RDM site, and an osprey (*Pandion haliaetus*) was observed foraging in the Kuskokwim River near the site.

## 2.7 Special Concern Species

### 2.7.1 Federally Listed Species

The United States Fish and Wildlife Service (2011) lists the following four species as being either endangered, threatened, or candidate species for Bethel County, Alaska:

- Short-tailed albatross (*Phoebastria albatrus*), federally listed endangered.
- Spectacled eider (*Somateria fischeri*), federally listed threatened.
- Steller’s eider (*Polysticta stelleri*), federally listed threatened.

- Kittlitz's murrelet (*Brachyramphus brevirostris*), federal candidate species.

Given their habitat preferences, none of these species are likely to occur at the RDM site. The short-tailed albatross is a sea bird that is sighted occasionally along the west coast of Alaska. The two eider species breed on wet, low-lying tundra along the north and west coasts of Alaska (Kaufman 1996). In other seasons, the spectacled eider and Steller's eider occur along the coast, where they forage by diving, mostly for mollusks. Kittlitz's murrelet is found along the Alaska coastline, being common mainly from Kodiak Island east to Glacier Bay (Kaufman 1996). It prefers cold sea waters, mostly in calm protected bays and among islands, usually close to shore.

#### 2.7.2 State Listed Species

The Alaska Natural Heritage Program (NHP) was contacted for current information on plant and animal species of concern in the vicinity of the Site. When available, the information provided by the Alaska NHP will be added to the SLERA or incorporated into the baseline ecological risk assessment (BERA) for the site.

## 3 ERAGS Step 1—Screening Level Problem Formulation and Ecological Effects Evaluation

### 3.1 Screening-Level Problem Formulation

Problem formulation is the first step in the risk assessment process. It identifies the goals, breadth, and focus of the assessment (EPA 1997, 1998). The problem formulation step identifies site-related contaminants (stressors), potential ecological receptors, and potential exposure pathways. A conceptual site model (CSM) is then developed to summarize the relationship between stressors and receptors. Lastly, assessment endpoints and measures (previously called measurement endpoints) are developed to guide the remaining steps of the risk assessment process. This section presents a preliminary problem formulation and CSM for the Site. The CSM may be refined during subsequent phases of the ERA process.

#### 3.1.1 Contaminant Sources and Migration Pathways

The RDM was Alaska's largest mercury mine, producing 1.2 million kilograms (kg; 2.73 million pounds) of mercury between 1933 and 1971 (Bailey et al. 2002). Cinnabar (HgS) and stibnite ($Sb_2S_3$) are the principal metallic minerals at the site, with minor amounts of realgar (AsS), orpiment ($As_2S_3$), and pyrite ($FeS_2$). High-grade ore from the mine contained as much as 30% mercury by weight, but most ore contained 2 to 5%. Several hundred meters of trenches, where surface mining took place, are present on the site. In addition, tailings and calcine piles are located on the site, several of which lie near Red Devil Creek. During a site investigation by the U. S. Geological Survey (Bailey et al. 2002), abundant cinnabar, lesser amounts of stibnite, and a few beads of liquid mercury were visible in Red Devil Creek. Additional information on the RDM site and previous site investigations is provided in the RI/FS Work Plan (E & E 2011).

Contaminated soil, crushed ore, tailings, and other wastes from the RDM have been exposed at the surface for decades. Mercury and other metals in these wastes were subject to transport by water and wind to Red Devil Creek, the Kuskokwim River, groundwater beneath the site, and surrounding terrestrial areas. In addition, liquid mercury at the site was subject to volatilization to the atmosphere. Approximately 10 years ago, the BLM conducted remedial work to address these problems. However, the success of the remedial work and current site conditions are not fully known.

### 3.1.2 Principal Site-Related Contaminants

Based on the minerals present at the site (see Section 3.1) and previous site assessment work (Ford 2001), mercury, methylmercury, antimony, and arsenic appear to be the primary Site-related contaminants, with the potential to adversely affect terrestrial and aquatic ecological receptors. In addition, due to accidental releases of fuel oil during past mining operations, diesel range organics (DRO) and perhaps other fuel-related organics (e.g., benzene, toluene, and polycyclic aromatic hydrocarbons [PAHs]) may be present at a level of concern in the historical fuel storage area and/or elsewhere at the site. Finally, lead may be present at elevated levels in soil at the locations of some historical mining structures (HLA/Wilder 2001).

### 3.1.3 Potential Ecological Receptors

Based on the site ecology, the following ecological receptor groups have the potential to be affected by site-related contaminants at the RDM site:

- Terrestrial plants and invertebrates.
- Mammals and birds that use the mine site, Red Devil Creek, and Kuskokwim River near the site to satisfy their food and habitat needs.
- Aquatic biota (e.g., amphibians, benthos, and fish) in Red Devil Creek and the Kuskokwim River.

### 3.1.4 Preliminary Conceptual Site Model

Figure 3-1 provides a preliminary ecological CSM for the site featuring the ecological receptor groups identified in the previous section. Terrestrial plants may be exposed to site-related chemicals by direct contact with contaminated soils, tailings, and overburden. Terrestrial invertebrates may be exposed to site-related contaminants through direct contact with contaminated soils, tailings, and overburden; ingestion of contaminated soils, tailings, and overburden; and through the food chain. Birds and mammals may be exposed to site-related chemicals through incidental ingestion of soil/sediment, tailings, and overburden; consumption of contaminated prey; and ingestion of contaminated surface water. It should be noted, however, that consumption of contaminated surface water typically accounts for only a minor fraction of total exposure for wildlife. Dermal exposure of wildlife to site-related chemicals is expected to be negligible compared with other exposure routes due to the protection provided by their external coverings (heavy fur and feathers). Fish and benthic invertebrates in Red Devil Creek and the Kuskokwim River may be exposed to site-related chemicals through direct contact with and ingestion of contaminated sediment and surface water and through the food chain.

### 3.1.5 Assessment Endpoints and Measures

In an ERA, assessment endpoints are expressions of the ecological resources that are to be protected (EPA 1997). An assessment endpoint consists of an ecological entity and a characteristic of the entity that is important to protect. According to the EPA (1998), assessment endpoints do not represent a desired achievement or goal and should not contain words such as "protect" or "restore" or indicate a direction for change such as loss or increase. Assessment endpoints are distinguished from management goals by their neutrality (EPA 1998).

Measurements used to evaluate risks to the assessment endpoints are termed "measures" and may include measures of effect, measures of exposure, and/or measures of ecosystem and receptor characteristics (EPA 1998). Based on the site ecology, primary site-related chemicals, and preliminary CSM, the ecological resources potentially at risk at the RDM site include terrestrial vegetation and invertebrates, mammals, birds, and aquatic biota (fish, amphibians, benthos, and other aquatic organisms). The assessment endpoints and measures for this screening level assessment are listed in Table 3.1.

### 3.1.6 Data Sources for the SLERA

The SLERA is based on chemical data for surface soil (0 to 2 feet below ground surface [bgs]), sediment (0 to 4 inches below the sediment surface), surface water, and vegetation samples collected from the RDM site in 2010 and 2011 for the RI/FS (E & E 2010, 2011). The Draft RI report (E & E 2012) presents full results for surface soil (RI Tables 4-17 to 4-23), surface water (RI Table 4-31), sediment (RI Tables 4-32 and 4-33), and vegetation (RI Table 4-34 to 4-37). Additionally, metals data for sculpin and benthic macroinvertebrates from Red Devil Creek collected by the BLM (2010) were used to help evaluate potential risks to aquatic-dependent wildlife. Draft reports are not yet available from the BLM for these data.

A value for total polychlorinated biphenyls (PCBs) in soil was calculated as the sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. One-half of the method detection limit (MDL) was used for non-detected Aroclors when calculating total PCBs. PAHs in soil and sediment were summed into low- and high molecular weight groups for evaluation. A value for low molecular weight PAHs (LPAHs) was calculated as the sum of acenaphthene, acenaphthylene, anthracene, fluorene, methylnaphthalene, naphthalene, and phenanthrene. A value for high molecular weight PAHs (HPAHs) was calculated as the sum of benz(a)anthracene, total benzofluoranthenes, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3,-c,d)pyrene, and pyrene. One-half of the MDL was used for non-detected PAHs when calculating HPAH and LPAH sums.

## 3.2 Screening Level Ecological Effects Evaluation

Screening levels for soil, sediment, and surface water were identified in the final Risk Assessment Work Plan (RAWP; E & E 2011, Appendix B) and are provided again in the screening tables in Section 4 in this report. For soil, EPA Ecological Soil Screening Level (Eco-SSLs) for effects on plants and soil invertebrates were used preferentially (EPA 2010). Efroyomson et al. (1997a, b) and Alloway (1990) were used as supplemental sources of soil screening levels. For sediment, threshold effect concentrations from MacDonald et al. (2000) were used preferentially. Supplemental sediment screening levels were taken from MacDonald et al. (1999) and Buchman (2008). Surface water screening levels were taken preferentially from EPA (2009) and Alaska DEC (2008, 2009). Supplemental surface water screening levels were taken from Suter and Tsao (1996). Fish tissue screening concentrations were taken from Dyer et al. (2000) and Sandheinrich and Wiener (2011).

Because media screening levels for effects on wildlife are not available for all media and chemicals, screening-level exposure estimates and hazard quotients (HQs) were calculated as per EPA (1997) for the wildlife receptors identified in the final RAWP (E & E 2011). Toxicity reference values (TRVs) used for this effort are provided in Table 3-2.

# 4 ERAGS Step 2:Screening Level Exposure Estimates and Risk Calculation

Screening-level exposure estimates and risk calculations are presented below for the terrestrial plant community (Section 4.1), soil invertebrate community (Section 4.2), benthic macroinvertebrate community (Section 4.3), fish and other aquatic biota (Section 4.4), and representative terrestrial and aquatic-dependent wildlife receptors (Section 4.5).

## 4.1 Terrestrial Plant Community Screening Level Exposure Estimate and Risk Calculation

Contaminants of potential concern (COPCs) for the terrestrial-plant community at the RDM site were selected by comparing maximum detected chemical concentrations in soil with soil screening levels for effects on plants. The results of the comparisons are shown in Table 4-1. The maximum concentrations of arsenic, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc exceeded the available screening levels. The greatest HQs were for arsenic (549) and mercury (5400), and greater than 95% of site samples exceeded the screening levels for these analytes. Soil screening levels for plants are not available for antimony, barium, beryllium, or several semivolatile organic compounds (SVOCs), so these analytes also were retained as COPCs for the terrestrial plant community.

## 4.2 Soil Invertebrate Community Screening Level Exposure Estimate and Risk Calculation

COPCs for the soil-invertebrate community at the RDM site were selected by comparing maximum detected chemical concentrations in soil with soil screening levels for effects on earthworms and other soil fauna. The results of the comparisons are shown in Table 4-1. The maximum concentrations of antimony, barium, copper, lead, manganese, mercury, and zinc exceeded the available screening levels. The greatest HQs were for antimony (299) and mercury (16200), and a high percentage of site samples exceeded the screening levels for these analytes. Soil screening levels for effects in soil invertebrates are not available for arsenic, chromium, cobalt, silver, thallium, vanadium, or several SVOCs, so these analytes also were retained as

COPCs for the soil invertebrate community.

### 4.3 Benthic Macroinvertebrate Community Exposure Estimate and Risk Calculation

COPCs for the benthic macroinvertebrate community in Red Devil Creek and Kuskokwim River near the RDM site were selected in two ways: (1) by comparing maximum detected chemical concentrations in sediment with sediment screening levels for effects on benthic macroinvertebrates and (2) by comparing maximum detected chemical concentrations in unfiltered surface water with chronic water criteria for protection of freshwater aquatic life. The results of the comparisons are shown in Tables 4-2 and 4-3.

The maximum sediment concentrations of antimony, arsenic, chromium, cobalt, copper, iron, manganese, mercury, nickel, and zinc exceeded the available screening levels (see Table 4-2). The greatest HQs were for antimony (2193), arsenic (13265), and mercury (661). Sediment screening levels were not available for barium, beryllium, methylmercury, thallium, or vanadium, so these five metals also were retained as COPCs in sediment for the benthic community.

Potential risks to benthic macroinvertebrates from chemicals in surface water are discussed in the following section.

### 4.4 Fish and Other Aquatic Biota Screening Level Exposure Estimate and Risk Calculation

COPCs for fish, amphibians, attached algae, benthic macroinvertebrates, and other aquatic organisms in Red Devil Creek were selected by comparing maximum detected chemical concentrations in unfiltered surface water with chronic water criteria for protection of freshwater aquatic life. The results of the comparisons are shown in Table 4-3. The maximum concentrations of antimony, arsenic, barium, iron, manganese, and mercury exceeded the available criteria, suggesting that these six constituents are COPCs in surface water for fish and other aquatic organisms. The greatest HQs were for barium (26) and mercury (32).

COPCs for fish were also selected by comparing maximum chemical concentration in whole-body sculpin samples from Red Devil Creek with fish tissue screening concentrations. The results of the comparisons are shown in Table 4-3b. The maximum sculpin concentrations of arsenic, chromium, mercury, methylmercury, selenium, and zinc exceeded the available fish tissue screening concentrations. The greatest HQs were for arsenic (14) and mercury (8). Fish tissue screening concentrations are not identified for antimony, barium, manganese, or vanadium, so these analytes also were retained as COPCs for fish.

### 4.5 Wildlife Screening Level Exposure Estimate and Risk Calculation

COPCs for wildlife were selected by calculating screening-level exposure estimates and HQs in accordance with EPA (1997) guidance. This method is preferable to comparing media concentrations with screening levels for several reasons: (1) soil screening levels for effects on wildlife are not available for all chemicals that were detected in soil at the RDM site; (2) sediment screening levels for evaluating risks to aquatic-dependent wildlife are rare; and (3) the HQ approach makes maximal use of available site-specific data on chemicals in terrestrial vegetation, benthic invertebrates, and fish, thus reducing the uncertainty associated with excessive use of literature-based bioaccumulation factors and models.

### 4.5.1 Wildlife Screening Level Exposure Estimates

This section describes the receptors, data, and methods used to derive screening-level exposure point concentrations and exposure estimates for wildlife at the RDM site.

#### 4.5.1.1 Summary of Datasets Used to Calculate Screening Level Exposure Estimates

Chemical analytical data for surface soil, sediment, surface water, and vegetation samples collected from the RDM site in 2010 and 2011 were used in the evaluation (see Tables 4-1 to 4-4, respectively). Also, metals data for benthic-macroinvertebrate and slimy-sculpin samples from Red Devil Creek collected by BLM were used to evaluate potential risks to aquatic-dependent wildlife. These data are summarized in Table 4-5 and 4-6, respectively.

#### 4.5.1.2 Exposure Scenarios and Pathways

Screening-level exposure estimates were calculated for the 11 wildlife receptors identified in the final RAWP. These species are:

Herbivores:

- Spruce grouse (*Dendragapus canadensis*)
- Tundra vole (*Microtus oeconomus*)
- Beaver (*Castor canadensis*)
- Green-winged teal (*Anus crecca*)

Invertivores

- Common snipe (*Gallinago gallinag*)
- American robin (*Turdus migra*torius)
- Masked shrew (*Sorex cinereus*)

Carnivores

- Northern shrike (*Lanius excubitor*)
- Least weasel (*Mustela nivalis*)

Piscivores:

- Belted kingfisher (*Ceryle alcyon*)
- Mink (M*ustela vison*)

For these species, chemical exposure from diet, incidental ingestion of soil and/or sediment, and drinking was estimated. Exposure parameters for these wildlife species were taken from the final RAWP and are presented in Table 4-7.

#### 4.5.1.3 Exposure Point Concentrations

For most receptors, maximum measured chemical concentrations in surface soil, sediment, surface water and biota were used to calculate the screening-level exposure estimates (see Table 4-8). However, for terrestrial wildlife species that prey on soil invertebrates (e.g., earthworms) and small mammals, literature-based models were used to estimate chemical concentration in prey. Maximum surface soil chemical concentrations were used as input to the models. Exposure point concentrations (EPCs) for the 11 wildlife species evaluated in the SLERA are presented in Tables 4-9 to 4-14. The models used to estimate chemical concentrations in earthworms and small mammals are provided in Tables 4-9 and 4-12.

#### 4.5.1.4 Exposure Calculations

Chemical exposure was calculated as the sum of exposures from diet, incidental soil/sediment ingestion, and drinking. Dietary exposure was estimated using the following equation:

$$EE_{diet} = C_f \text{ x } IR/BW$$

Where:

| | | |
|---|---|---|
| $EE_{diet}$ | = | Estimated exposure from diet (milligrams [mg] per kilogram [kg] per day) |
| $C_f$ | = | Chemical concentration in food (mg/kg, wet or dry weight) |
| $IR_f$ | = | Food ingestion rate of receptor (kg/day, wet or dry weight) |
| BW | = | Body weight of receptor (kg) |

Food ingestion rates and body weights were evaluated were taken from EPA (1993a), Dunning (1993), or other credible references (see Table 4-7). The diet of each receptor was assumed to consist exclusively of its preferred prey (see Table 4-7). For example, the diets of the American robin and marked shrew were assumed to consist entirely of soil invertebrates (e.g., earthworms). A wet food ingestion rate was used for the common snipe, kingfisher, and mink because chemical concentration data for benthic invertebrates and fish (sculpin) were provided on a wet weight basis. A dry food ingestion rate was used for all other receptors because site-specific data on chemical concentrations in their preferred food were provided on a dry weight basis (spruce needles, blueberry leaves, alder back, and pond vegetation) or because the models used to estimate chemical concentration in their preferred food yielded a dry weigh concentration (earthworms and small mammals).

Wildlife exposure to chemicals through incidental soil/sediment ingestion was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{soil/sed} = C_s \times IR_s/BW$$

Where:

$EE_{soil/sed}$ = Estimated exposure from incidental soil/sediment ingestion (mg/kg/day)
$C_s$ = Chemical concentration in soil/sediment (mg/kg, dry weight)
$IR_s$ = Soil/sediment ingestion rate of receptor (kg/day, dry weight)

Soil/sediment ingestion rates were taken from pertinent literature (Beyer et al. 1994, 2008; Sample et al. 1997; Sample and Suter 1994) or based on professional judgment (if a literature value could not be found) (see Table 4-7).

Wildlife exposure to chemicals through drinking was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{drinking} = C_w \times IR_w/BW$$

Where:

$EE_{drinking}$ = Estimated exposure from drinking surface water (mg/kg/day)
$C_w$ = Chemical concentration in surface water (milligrams/liter)
$IR_w$ = Surface water ingestion rate (liters/day)

Surface water ingestion rates were taken from the literature or calculated using allometric relationships from Sample et al. (1996). The values are provided in Table 4-7.

The total exposure for a receptor was calculated as the sum of the exposure from diet, incidental soil/sediment ingestion, and drinking as represented by the following equation:

$$EE_{total} = EE_{diet} + EE_{soil/sed} + EE_{drinking}$$

Where:

$EE_{total}$ = Total exposure (mg/kg/day)
$EE_{diet}$ = Estimated exposure from diet (mg/kg/day)
$EE_{soil/sed}$ = Estimated exposure from incidental soil/sediment ingestion (mg/kg/day)
$EE_{drinking}$ = Estimated exposure from surface water consumption (mg/kg/day)

Lastly, all wildlife receptors evaluated in the SLERA were assumed to derive all of their food and water from the site and be year-round residents. That is, the site use factor (SUF) and exposure duration (ED) were assumed to be 1.0 for all receptors.

Tables 4-15 to 4-25 present the exposure estimates for the 11 wildlife species evaluated in the SLERA.

### 4.5.2 Wildlife Screening-Level Risk Calculation

Potential risks posed by site-related chemicals were determined by calculating an HQ for each chemical for each endpoint species. The HQs were calculated by dividing the total exposure ($EE_{total}$) by the appropriate no observed adverse effect level (NOAEL; see Table 3-2), as shown in the following equation:

$$HQ = EE_{total}/NOAEL$$

For a given receptor and chemical, an HQ greater than or equal to 1 indicates that a potential risk exists and that further evaluation is warranted in the BERA.

Tables 4-15 to 4-25 present the screening-level HQs for the 11 wildlife species evaluated in the SLERA. In general, the wildlife endpoint species potentially at risk from the greatest number of chemicals are those that feed extensively on invertebrates that live in soil, such as the American robin and masked shrew (see Tables 4-15 and Table 4-16, respectively), or sediment, such as the common snipe (see Table 4-21). For many receptors, the highest HQs typically were those for antimony, arsenic, and mercury, as would be expected given the nature and extent of contamination at the site. For the American robin, masked shrew, and spruce grouse, potential risks from lead also were high, largely due to an anomalously high maximum lead concentration in surface soil.

## 5 Uncertainties

Significant sources of uncertainty in this ERA include the following:

- **Bioavailability –** The bioavailability of chemicals in environmental media at the RDM +site is poorly understood. To be conservative, it was assumed that 100% of the chemicals in soil and sediment were bioavailable to all ecological receptors. If bioavailability is less than 100%, which seems likely, the potential risks to all categories of ecological receptors would be correspondingly lower. In the BERA, this issue will be examined by evaluating site-specific data for mercury and arsenic speciation in soil and sediment, as well as synthetic precipitation leaching procedure data for metals in soil.
- **Reliability of Soil Benchmarks –** Many of the available soil screening benchmarks for plants and soil invertebrates (i.e., earthworms) were developed from laboratory studies in which chemical solutions were added to clean soil to arrive at a range of test concentrations. In such studies, the added chemicals are highly bioavailable. Comparing total chemical concentrations in field samples to solution-based soil benchmarks is conservative and likely results in an overestimation of risk. For aluminum, the EPA (2003) has deemed that such a comparison is inappropriate.
- **Reliability of Sediment Benchmarks –** The available sediment benchmarks are based on total concentrations without consideration of chemical bioavailability. The sediment benchmarks used in the SLERA are expected to be overly conservative predictors of no-

effect levels for benthic organisms in Red Devil Creek, given that a large fraction of many site-related contaminants occur largely in an inert crystalline form.

- **Availability of Media Screening Levels and Wildlife TRVs –** As indicated in Tables 4-1 to 4-3, screening levels are not available for all chemicals in all media. For example, soil screening levels for plants and soil fauna are not available for SVOCs. Hence, potential risks to plants and soil fauna from many SVOCs could not be evaluated. Additionally, an avian TRV is not available for antimony. Hence, potential risks to birds from antimony, which is one of the principal contaminants at the RDM site, could not be evaluated.
- **Chemicals in Wildlife Prey –** Food-chain transfer of chemicals at the RDM site is poorly understood for terrestrial predatory wildlife (e.g., American Robin, masked shrew, northern shrike, and least weasel). The potential risks to these species are largely driven by estimated concentrations of chemicals in wildlife prey. For this assessment, prey concentrations were estimated from measured soil and sediment concentrations using bioaccumulation factors and models from the literature. Or, if a literature-based bioaccumulation factor was not available, it was assumed that the prey concentration was the same as the soil or sediment concentration. The uncertainty associated with this approach often is high because a number of site-specific factors affect food-chain transfer of chemicals. In general, the bioaccumulation factors and models used in this assessment are intended to provide a conservative estimate of chemicals in wildlife prey and are likely to result in an overestimation of risk.
- **Wildlife Diet –** Uncertainty may result from the assumptions made about the diets of the wildlife receptors evaluated in this assessment. For the shrew and robin, the assumption of a diet consisting entirely of earthworms is conservative. In addition to earthworms, shrews consume other invertebrates (i.e., slugs, snails, centipedes, and various insects), fungi, plant materials, and small mammals (EPA 1993a). Similarly, robins also consume other invertebrates (i.e., spiders, sowbugs, and various insects) and plant materials (EPA 1993a). These foods are less intimately associated with the soil matrix than earthworms, and thus accumulate lesser amounts of soil contamination. The diet assumed for the shrew and robin in this assessment likely overestimates exposure and risks from chemicals in soil.
- **Site Use Factor and Exposure Duration** – To provide a conservative estimate of wildlife exposure to site-related chemicals, the SUF and ED were assumed to be 1 for all receptors. That is, the site was assumed to be a closed system, and all wildlife species were assumed to derive all of their food and habitat requirements from the site on a year-round basis. These assumptions are highly conservative and often are used in screening-level ERAs to avoid overlooking chemicals that may be of concern for wildlife (EPA 1997). If realistic estimates of the SUF and ED were incorporated into the wildlife exposure calculation, the estimated exposure and risk would be substantially lower.
- **Reliability of Surface Water Criteria –** In general, the EPA's water quality criteria and State of Alaska water quality standards are considered to be among the most reliable

screening levels because they are based on a large body of testing data and sound derivation methods. However, there are exceptions. For example, the mercury water quality criterion of 0.012 micrograms per liter (µg/L) from EPA (1986) is a Final Residue Value that was derived from a bioconcentration factor of 81,700 for methylmercury with the fathead minnow and thus assumes that all discharged mercury is methylmercury. Use of this criterion as a screening level for total mercury is highly conservative, given that only a small fraction of total mercury in surface water is present as methylmercury.

- **Reliability of Other Surface Water Screening Levels –** The EPA and State of Alaska water quality criteria are not available for all chemicals. For such chemicals, surface water screening levels from other sources were used (see Table 4-3). These other surface water screening levels are based on less testing data than federal and state water quality criteria, and therefore the level of uncertainty associated with them is greater.

# 6 Summary of Chemicals of Potential Concern

The primary purpose of the SLERA was to select COPCs for the BERA. Table 4-26 provides a summary of the chemical and receptor combinations that will be evaluated in the BERA. For each assessment endpoint, chemicals were retained for evaluation in the BERA if the screening-level HQ equaled or exceeded 1 or if the chemical was detected in site media and no toxicity information was available for that chemical. The later group of chemicals includes several organic compounds that were detected infrequently at low (part per billion) levels in soil or sediment (see Table 4-26). These chemicals will be addressed qualitatively in the BERA.

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# 8 Acronyms and Abbreviations

| | |
|---|---|
| °C | degrees centigrade |
| °F | degrees Fahrenheit |
| $As_2S_3$ | orpiment |
| AsS | realgar |
| BERA | baseline ecological risk assessment |
| bgs | below ground surface |
| BLM | United States Department of the Interior Bureau of Land Management |
| cm | centimeters |
| COPCs | Contaminants of potential concern |
| CSM | conceptual site model |
| DBH | diameter at breast height |
| DRO | diesel range organics |
| Eco-SSLs | EPA Ecological Soil Screening Level |
| ED | exposure duration |
| ERAGS | United States Environmental Protection Agency Risk Assessment Guidance |
| $FeS_2$ | pyrite |
| HgS | Cinnabar |
| HPAHs | high molecular weight PAHs |
| HQ | hazard quotient |
| kg | kilograms |
| LPAHs | low molecular weight PAHs |
| MDL | method detection limit |
| mg | milligrams |
| NHP | Natural Heritage Program |
| ORNL | Oak Ridge National Laboratory |
| PAHs | polycyclic aromatic hydrocarbons |
| PCBs | polychlorinated biphenyls |
| RAWP | Risk Assessment Work Plan |
| RDM | Red Devil Mine |
| RI/FS | Remedial Investigation/Feasibility Study |
| $Sb_2S_3$ | stibnite |
| SLERA | Screening Level Ecological Risk Assessment |
| SUF | site use factor |
| SVOCs | semivolatile organic compounds |
| TRV | Toxicity reference value |

**Table ES-1 Summary of Chemical and Endpoint Combinations to be Evaluated in the Baseline Ecological Risk Assessment, Red Devil Mine Site**

| Analyte[b] | Assessment Endpoint and Maximum HQ[a] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Terrestrial Wildlife[h] | | | | | | Aquatic-Dependent Wildlife[i] | | | | |
| | Plants[c] | Soil Fauna[d] | Fish and Other Aquatic Biota[e] | Fish[f] | Benthos[g] | Robin | Shrew | Grouse | Vole | Shrike | Weasel | Snipe | Beaver | Teal | Kingfisher | Mink |
| **Polychlorinated Biphenyls (PCBs)** | | | | | | | | | | | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | | x | | | | | | | | | | | | | | |
| **Metals** | | | | | | | | | | | | | | | | |
| Antimony | x | 299 | 6.1 | x | 2,193 | x | **136,370** | x | **1,681** | x | | x | **60** | x | x | **89** |
| Arsenic | 549 | x | 6.9 | 14 | 13,265 | **28** | **214** | **47** | **41** | **1.5** | **1.9** | **823** | **1.5** | **37** | **5.5** | **3.3** |
| Barium | x | 5.2 | 26 | x | x | **2.0** | **1.6** | **1.3** | | | | **1.4** | | | | |
| Beryllium | x | | | | x | x | | x | | x | | x | | x | x | |
| Cadmium | | | | | | **1.7** | **4.4** | | | | | | | | | |
| Chromium | 1.3 | x | | 3.5 | 1.1 | **2.9** | **1.3** | | | | | | | | | |
| Cobalt | 3.0 | x | | | 1.0 | | | | | | | | | | **1.1** | |
| Copper | 2.0 | 1.7 | | | 2.8 | **4.4** | **4.6** | | | | | **1.5** | | | | |
| Iron | | | 2.5 | | 16 | | | | | | | | | | | |
| Lead | 26 | 1.8 | | | | **83** | **48** | **20** | **2.8** | **4.9** | **1.0** | | | | | |
| Manganese | 19 | 9.4 | 3.2 | x | 12 | | **2.3** | **2.1** | **6.1** | | | | | | | |
| Mercury | 5,400 | 16,200 | 32 | 8 | 661 | **9.5** | **2.1** | **39** | | | | **5.8** | | **2.8** | **4.2** | |
| Methylmercury | | | | 1 | x | | | | | | | | | | **2.3** | **1.3** |
| Nickel | 2.6 | | | | 11 | **3.7** | **21** | | | | | | | | | |
| Selenium | | | | 2.7 | | | **1.2** | | | | | **5.7** | | | **5.2** | **2.9** |
| Silver | | x | | | | | | | | | | | | | | |
| Thallium | | x | | | x | x | **3.3** | x | | x | | x | | x | x | **3.8** |
| Vanadium | 26 | x | | | x | **1.9** | | **1.7** | | | | **2.5** | | | | |
| Zinc | 2.4 | 3.2 | | 1.3 | 1.1 | **2.2** | **2.7** | | | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | | | | | | | | | | | |
| HPAH sum | | | | | | | | | | | | | | | | |
| LPAH sum | | | | | | x | | x | | x | | x | | | x | |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | | | | | | | | | | | |
| 4-Bromophenyl phenyl ether | x | x | | | | x | x | x | x | x | x | | x | | | |
| 4-Methylphenol | x | x | | | | x | | x | | x | | | | | | |
| Benzoic acid | x | x | | | | x | x | x | x | x | x | | x | | | |
| Benzyl Alcohol | x | x | | | | x | x | x | x | x | x | x | x | | x | x |
| Bis(2-Ethylhexyl)phthalate | x | x | | | | | | | | | | | | | | |
| Dibenzofuran | | | | | | x | x | x | x | x | x | | x | | | |
| Diethylphthalate | | x | | | | x | | x | | x | | x | | | x | |
| Dimethylphthalate | x | | | | | x | x | x | x | x | x | | x | | | |
| Di-n-butyl Phthalate | | | | | | | | | | | | | | | | |
| Hexachlorobenzene | x | | | | | | | | | | | | | | | |
| Pentachlorophenol | | | | | | | | | | | | | | | | |
| Phenol | | | | | | | | | | | | | | | | |

Key:
BERA = Baseline Ecological Risk Assessment
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
TRV = toxicity reference value
Value (with or without shading) = HQ equal to or greater than 1. Chemical and receptor combination will be evaluated quantitatively in the BERA.
x = chemical detected in site samples but no screening level or TRV is available. Chemical will be evaluated qualitatively in the BERA.

Notes:
a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):

| | |
|---|---|
| Value | = > 75% |
| Vaue | = 50 - 75% |
| Value | = 25 - 50% |
| Value | = < 25% |

For wildlife, the value of the maximum HQ (exposure estimate / TRV) is shown without shading because wildlife HQs were not calculated sample-by-sample.

b. Essential nutrients (calcium, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per USEPA guidance (USEPA 1989, 2003a). Organic chemicals detected in surface soil, sediment, or surface water are listed.

c. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on plants (see Table 4-1).

d. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on earthworms (see Table 4-1).

e. Based on comparing maximum surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see Table 4-3).

f. Based on comparing maximum whole-body scuplin chemical concentrations with fish tissue screening concentrations (see Table 4-3b).

g. Based on comparing maximum sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see Table 4-2).

h. Based on screening-level exposure estimates and hazard quotients for the American robin (Table 4-15), masked shrew (Table 4-16), spruce grouse (Table 4-17), tundra vole (Table 4-18), northern shrike (Table 4-19), and least weasel (Table 4-20).

i. Based on screening-level exposure estimates and HQs for the common snipe (Table 4-21), beaver (Table 4-22), green-winged teal (Table 4-23), belted kingfisher (Table 4-24), and mink (Table 4-25).

Table 3-1 Assessment Endpoints and Measures for the Red Devil Mine Site Screening Level Ecological Risk Assessment

| Assessment Endpoint | Risk Question | Measure Selected for SLERA | Analysis Approach |
|---|---|---|---|
| **Terrestrial Vegetation** | | | |
| Survival, growth, and reproduction or terrestrial plants | Are levels of contaminants in surface soil from the site greater than benchmarks for effects on survival, growth, or reproduction of terrestrial plants? | Chemical concentrations in soil. | Compare soil chemical concentrations with literature-based toxicity thresholds. |
| **Soil Invertebrates** | | | |
| Survival, growth, and reproduction or soil invertebrates | Are levels of contaminants in surface soil from the site greater than benchmarks for effects on survival, growth, or reproduction of soil invertebrates? | Chemical concentrations in soil. | Compare soil chemical concentrations with literature-based toxicity thresholds. |
| **Birds** | | | |
| | Does the daily dose of chemicals received by birds from consumption of prey and other media at the site exceed TRVs for survival, growth, or reproduction of birds? | Chemical concentration in surface water, sediment, soil, and modeled or measured tissue concentrations in prey species. | Modeled dose from diet, surface water ingestion, and incidental ingestion of soil or sediment compared with literature-based TRVs. |
| **Mammals** | | | |
| | Does the daily dose of chemicals received by mammals from consumption of prey and other media at the site exceed TRVs for survival, growth, or reproduction of mammals? | Chemical concentration in surface water, sediment, soil, and modeled or measured tissue concentrations in prey species. | Modeled dose from diet, surface water ingestion, and incidental ingestion of soil or sediment compared with literature-based TRVs. |
| **Benthic Invertebrates** | | | |
| Survival, growth, and reproduction or benthic invertebrates | Are levels of contaminants in sediment from Red Devil Creek and the Kuskokwim River greater than sediment benchmarks for survival, growth, or reproduction of benthic invertebrates? | Chemical concentrations in sediment. | Compare sediment chemical concentrations with literature-based toxicity thresholds. |
| | Are levels of contaminants in surface water from Red Devil Creek greater than water quality criteria for protection of aquatic life? | Chemical concentrations in surface water. | Compare surface water chemical concentrations with federal and state water quality criteria and standards. |
| **Fish and Other Aquatic Biota (e.g., amphibians, attached algae, and aquatic invertebrates)** | | | |
| Survival, growth, and reproduction of fish and other aquatic biota | Are levels of contaminants in surface water from Red Devil Creek greater than water quality criteria for protection of aquatic life? | Chemical concentrations in surface water. | Compare surface water chemical concentrations with federal and state water quality criteria and standards. |
| **Fish** | | | |
| Survival, growth, and reproduction or fish | Are levels of contaminants in fish from Red Devil Creek greater than critical tissue concentrations for effects on fish? | Whole-body chemical concentrations in slimy sculpin from Red Devil Creek. | Compare chemical concentrations in whole-body sculpin samples from Red Devil Creek with fish tissue screening concentrations. |

Key:
SLERA = Screening Level Ecological Risk Assessment
TRVs = toxicity reference values

**Table 3-2 Toxicity Reference Values for Birds and Mammals**

| Analyte | Wildlife Class | NOAEL (mg/kg-day) | Critical Effect | LOAEL (mg/kg-day) | Critical Effect | Reference and Comments |
|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls** | | | | | | |
| Aroclors 1260 | Birds | 0.18 | Reproduction | 1.8 | Reproduction | Sample et al. (1996) for Aroclor 1254. |
| | Mammals | 0.14 | Reproduction | 0.69 | Reproduction | Sample et al. (1996) for Aroclor 1254 effects on mink. |
| **Metals** | | | | | | |
| Antimony | Birds | na | na | na | na | na |
| | Mammals | 0.059 | Reproduction | 0.59 | Reproduction | USEPA (2005i). Highest bounded NOAEL (0.059 mg/kg-d) for growth or reproduction below lowest bounded LOAEL (0.59 mg/kg-d) for growth or reproduction from 20 laboratory toxicity studies. |
| Arsenic | Birds | 2.24 | Reproduction | 3.55 | Growth | USEPA(2005b). Lowest NOAEL for growth, reproduction, or survival from nine laboratory toxicity studies. Lowest LOAEL for growth, reproduction, or survival greater than selected NOAEL. |
| | Mammals | 1.04 | Growth | 1.66 | Growth | USEPA (2005b). Highest bounded NOAEL for growth, reproduction, or survival less than lowest bounded LOAEL for growth, reproduction, or survival from 62 laboratory toxicity studies. |
| Barium | Birds | 20.8 | Survival | 41.7 | Survival | Sample et al. (1996). |
| | Mammals | 51.8 | Reproduction, growth, and survival | 121 | Growth and survival | USEPA (2005c). Geometric mean NOAEL for growth, reproduction, and survival from 12 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL. |
| Beryllium | Birds | na | na | na | na | na |
| | Mammals | 0.532 | Survival | na | na | USEPA (2005d). Lowest NOAEL for growth, reproduction, or survival from four laboratory toxicity studies. |
| Cadmium | Birds | 1.47 | Reproduction, growth, and survival | 2.37 | Reproduction | USEPA (2005e). Geometric mean NOAEL for growth, reproduction, and survival from 49 laboratory toxicity studies. Lowest bounded LOAEL for growth, reproduction, or survival greater than geometric mean NOAEL. |
| | Mammals | 0.77 | Growth | 1 | Growth | USEPA (2005e). Highest bounded NOAEL (0.77 mg/kg-d) for reproduction, growth, or survival less than the lowest bounded LOAEL (1.0 mg/kg-d) from 141 laboratory toxicity studies. |
| Chromium | Birds | 2.66 | Reproduction, growth, and survival | 2.78 | Survival | USEPA (2008). Geometric mean NOAEL for growth, reproduction, and survival from 17 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL. |
| | Mammals | 9.24 | Reproduction and growth | na | na | USEPA (2008). Geometric mean NOAEL for reproduction and growth from 10 studies with trivalent chromium. |
| Cobalt | Birds | 7.61 | Growth | 7.8 | Growth | USEPA (2005f). Geometric mean NOAEL for growth from 10 toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL. |
| | Mammals | 7.33 | Reproduction and Growth | 10.9 | Reproduction | USEPA (2005f). Geometric mean NOAEL for reproduction and growth based on 21 laboratory toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL. |
| Copper | Birds | 4.05 | Reproduction | 4.68 | Growth | USEPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (4.05 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (4.68 mg/kg-day). |
| | Mammals | 5.6 | Reproduction | 6.79 | Growth | USEPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (5.6 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (6.79 mg/kg-day). |
| Lead | Birds | 1.63 | Reproduction | 1.94 | Reproduction | USEPA (2005g). Highest bounded NOAEL (1.63 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (1.94 mg/kg-d) for growth, reproduction, or survival based on 57 laboratory toxicity studies. |
| | Mammals | 4.7 | Growth | 5 | Growth | USEPA (2005g). Highest bounded NOAEL (4.7 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (5 mg/kg-d) for growth, reproduction, or survival based on 220 laboratory toxicity studies. |
| Manganese | Birds | 179 | Reproduction and Growth | 348 | Growth | USEPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |

Table 3-2 Toxicity Reference Values for Birds and Mammals

| Analyte | Wildlife Class | NOAEL (mg/kg-day) | Critical Effect | LOAEL (mg/kg-day) | Critical Effect | Reference and Comments |
|---|---|---|---|---|---|---|
| | Mammals | 51.5 | Reproduction and Growth | 65 | Growth | USEPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| Mercury | Birds | 0.45 | Reproduction | 0.9 | Reproduction | Sample et al. (1996). |
| | Mammals | 13.2 | Reproduction and survival | na | na | Sample et al. (1996). |
| Methylmercury | Birds | 0.068 | Reproduction | 0.37 | Reproduction | CH2MHILL (2000). |
| | Mammals | 0.032 | Reproduction | 0.16 | Reproduction | CH2MHILL (2000). |
| Nickel | Birds | 6.71 | Growth and survival | 11.5 | Growth | USEPA (2007c). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| | Mammals | 1.7 | Reproduction | 2.71 | Reproduction | USEPA (2007c). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival. |
| Selenium | Birds | 0.291 | Survival | 0.368 | Reproduction | USEPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival. |
| | Mammals | 0.143 | Growth | 0.145 | Reproduction | USEPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival. |
| Silver | Birds | 2.02 | Growth | 20.2 | Growth | USEPA (2006). Lowest LOAEL for reproduction or growth divided by 10. |
| | Mammals | 6.02 | Growth | 60.2 | Growth | USEPA (2006). Lowest LOAEL for reproduction or growth divided by 10. |
| Thallium | Birds | NA | NA | NA | NA | NA |
| | Mammals | 0.0074 | Reproduction | 0.074 | Reproduction | Sample et al. (1996). |
| Vanadium | Birds | 0.344 | Growth | 0.413 | Reproduction | USEPA (2005h). Highest bounded NOAEL (0.344 mg/kg-d) for growth, reproduction, or survival less than lowest bounded LOAEL (0.413 mg/kg-d) for reproduction, growth, or survival based on 94 laboratory toxicity studies. |
| | Mammals | 4.16 | Reproduction and growth | 5.11 | Growth | USEPA (2005h). Highest bounded NOAEL (4.16 mg/kg-d) for growth or reproduction less than lowest bounded LOAEL (5.11 mg/kg-d) for growth, reproduction, or survival based on 94 laboratory toxicity studies. |
| Zinc | Birds | 66.1 | Reproduction and Growth | 66.5 | Reproduction | USEPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| | Mammals | 75.4 | Reproduction and Growth | 75.9 | Reproduction | USEPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL. |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | |
| LPAHs[a] | Birds | na | na | na | na | na |
| | Mammals | 65.6 | Growth | 110 | Growth | USEPA (2007f). Highest bounded NOAEL (65.5 mg/kg-d) below the lowest bounded LOAEL (110 mg/kg-d) for reproduction, growth, or survival. |
| HPAHs[b] | Birds | 2 | Growth | 20 | Growth | USEPA (2007f); from Appendix 5.2A for European starling. |
| | Mammals | 0.615 | Survival | 3.07 | Survival | USEPA (2007f). Highest bounded NOAEL (0.615 mg/kg-day) below the lowest bounded LOAEL (3.07 mg/kg-day) for reproduction, growth, or survival. |
| **Other Semivolatile Organic Compounds** | | | | | | |
| 4-Bromophenyl phenyl ether | Birds | na | na | na | na | na |
| | Mammals | na | na | na | na | na |
| 4-Methylphenol | Birds | na | na | na | na | na |
| | Mammals | 219 | na | na | na | NYSDEC (2002). |
| Benzoic Acid | Birds | na | na | na | na | na |
| | Mammals | na | na | na | na | na |
| Benzyl Alcohol | Birds | na | na | na | na | na |
| | Mammals | na | na | na | na | na |
| Bis(2-ethylhexyl)phthalate | Birds | 1.11 | Reproduction | na | na | Sample et al. (1996). |
| | Mammals | 18.33 | Reproduction | 183.3 | Reproduction | Sample et al. (1996). |
| Butyl Benzyl Phthalate | Birds | na | na | na | na | na |
| | Mammals | na | na | na | na | na |
| Diethyl Phthalate | Birds | na | na | na | na | na |
| | Mammals | 4583 | Reproduction | na | na | Sample et al. (1996). |

**Table 3-2 Toxicity Reference Values for Birds and Mammals**

| Analyte | Wildlife Class | NOAEL (mg/kg-day) | Critical Effect | LOAEL (mg/kg-day) | Critical Effect | Reference and Comments |
|---|---|---|---|---|---|---|
| Dimethyl Phthalate | Birds | na | na | na | na | na |
| | Mammals | na | Reproduction | na | na | na |
| Di-n-butyl Phthalate | Birds | 0.11 | Reproduction | 1.1 | Reproduction | Sample et al. (1996). |
| | Mammals | 550 | Reproduction | 1833 | Reproduction | Sample et al. (1996). |
| Hexachlorobenzene | Birds | 0.56 | Reproduction | 2.25 | Reproduction | Sample et al. (1996) for BHC mixed isomers. |
| | Mammals | 0.014 | Reproduction | 0.14 | Reproduction | Sample et al. (1996) for BHC mixed isomers. |
| Pentachlorophenol | Birds | 6.73 | Reproduction | na | na | USEPA (2007g). Lowest NOAEL for reproduction, growth, or survival. |
| | Mammals | 8.42 | Reproduction and Growth | 9.45 | Reproduction | USEPA (2007g). NOAEL value is geometric mean of 25 NOAELs for reproduction and growth. LOAEL value is lowest LOAEL greater than geometric mean NOAEL. |
| Phenol | Birds | 6 | na | na | na | NYSDEC (2002). |
| | Mammals | 523 | na | na | na | NYSDEC (2002). |

Key:
BHC = benzene hexachloride
HPAH = high molecular weight PAH
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
na = no available
NOAEL = no observed adverse effect level
PAH = polycyclic aromatic hydrocarbon
TRV = toxicity reference value

Notes:
a. Sum of acenaphthylene, acenaphthene, anthracene, fluorene, methylnaphthalene, naphthalene, and phenanthrene.
b. Sum of benz(a)anthracene, total benzofluoranthenes, benzo(a)pyrene,chrysene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3,-c,d)pyrene, fluoranthene, and pyrene.

Table 4-1 Surface Soil (0 to 2 feet) Ecological Screening Results, Red Devil Mine Site SLERA

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | FoD | Soil Ecological Screening Levels and Hazard Quotients | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Plants | | | | | Soil Invertebrates | | | | |
| | | | | | Value[c] | FoE | HQ[e] | COPC | Rationale[f] | Value[d] | FoE | HQ[e] | COPC | Rationale[f] |
| **Metals (mg/kg)** | | | | | | | | | | | | | | |
| Aluminum | 135 | 2410 | 21700 | 135/135 | -- | -- | -- | No | MSC | -- | -- | -- | No | MSC |
| Antimony | 135 | 0.708 J | 23300 J | 111/135 | -- | -- | -- | Yes | NSL | 78 | 86/135 | 299 | Yes | >SL |
| Arsenic | 135 | 9 | 9880 | 134/135 | 18 | 126/134 | 549 | Yes | >SL | -- | -- | -- | Yes | NSL |
| Barium | 135 | 76.2 | 1710 | 135/135 | -- | -- | -- | Yes | NSL | 330 | 41/135 | 5.2 | Yes | >SL |
| Beryllium | 135 | 0.3 | 1.3 | 132/135 | -- | -- | -- | Yes | NSL | 40 | 0/1354 | 0.03 | No | <SL |
| Cadmium | 135 | 0.18 | 1.3 | 38/135 | 32 | 0/36 | 0.04 | No | <SL | 140 | 0/135 | 0.01 | No | <SL |
| Calcium | 135 | 390 | 10400 J | 135/135 | -- | -- | -- | No | NUT | -- | -- | -- | No | NUT |
| Chromium | 135 | 6 | 101 | 135/135 | 75 | 1/135 | 1.3 | Yes | >SL | -- | -- | -- | Yes | NSL |
| Cobalt | 135 | 5.9 | 38.8 | 135/135 | 13 | 103/135 | 3.0 | Yes | >SL | -- | -- | -- | Yes | NSL |
| Copper | 135 | 17 | 139 | 135/135 | 70 | 56/135 | 2.0 | Yes | >SL | 80 | 30/135 | 1.7 | Yes | >SL |
| Iron | 135 | 16800 | 59100 | 135/135 | -- | -- | -- | No | MSC | -- | -- | -- | No | MSC |
| Lead | 135 | 5 | 3090 | 126/135 | 120 | 6/126 | 26 | Yes | >SL | 1700 | 1/135 | 1.8 | Yes | >SL |
| Magnesium | 135 | 390 | 11400 | 135/135 | -- | -- | -- | No | NUT | -- | -- | -- | No | NUT |
| Manganese | 135 | 153 | 4230 | 135/135 | 220 | 133/135 | 19 | Yes | >SL | 450 | 111/135 | 9.4 | Yes | >SL |
| Mercury | 135 | 0.05 J | 1620 | 135/135 | 0.3 | 126/135 | 5400 | Yes | >SL | 0.1 | 133/135 | 16200 | Yes | >SL |
| Methylmercury | 0 | -- | -- | 0/0 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Nickel | 135 | 18 | 97 | 135/135 | 38 | 101/135 | 2.6 | Yes | >SL | 280 | 0/135 | 0.35 | No | <SL |
| Potassium | 135 | 600 | 4720 | 135/135 | -- | -- | -- | No | NUT | -- | -- | -- | No | NUT |
| Selenium | 135 | 0.24 | 0.42 | 2/135 | 0.52 | 0/2 | 0.81 | No | <SL | 4.1 | 0/135 | 0.10 | No | <SL |
| Silver | 135 | 0.068 | 0.123 | 2/135 | 560 | 0/2 | 0.0002 | No | <SL | -- | -- | -- | Yes | NSL |
| Sodium | 135 | 42.3 | 430 | 75/135 | -- | -- | -- | No | NUT | -- | -- | -- | No | NUT |
| Thallium | 135 | 0.065 | 0.071 | 2/135 | 1 | 0/135 | 0.07 | No | <SL | -- | -- | -- | Yes | NSL |
| Vanadium | 135 | 15.3 | 51.9 | 135/135 | 2 | 135/135 | 26 | Yes | >SL | -- | -- | -- | Yes | NSL |
| Zinc | 135 | 38 | 386 | 135/135 | 160 | 4/135 | 2.4 | Yes | >SL | 120 | 35/135 | 3.2 | Yes | >SL |
| **Polychlorinated Biphenyls (PCBs) (µg/kg)** | | | | | | | | | | | | | | |
| Aroclor-1260 | 18 | 0.021 J | 0.021 J | 1/18 | 40,000 | 0/1 | 0.0000 | No | <SL | -- | -- | -- | Yes | NSL |
| Sum of Aroclors (NDs = 0.5 MDL) | 18 | 0.078 J | 0.078 J | 1/18 | 40,000 | 0/1 | 0.0000 | No | <SL | -- | -- | -- | Yes | NSL |
| **Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)** | | | | | | | | | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 12 | 10.7 | 109 | 5/12 | 20,000 | 0/5 | 0.01 | No | <SL | 18000 | 0/5 | 0.01 | No | <SL |
| LPAH sum (NDs = 0.5 MDL) | 12 | 15.3 | 417 | 6/12 | 20,000 | 0/6 | 0.02 | No | <SL | 29000 | 0.6 | 0.01 | No | <SL |
| **Other Semivolatile Organic Compounds (SVOCs) (µg/kg)** | | | | | | | | | | | | | | |
| 4-Bromophenyl Phenyl Ether | 12 | 1.9 J | 1.9 J | 1/12 | -- | -- | -- | Yes | NSL | -- | -- | -- | Yes | NSL |
| 4-Methylphenol | 12 | 4.9 J | 4.9 J | 1/12 | -- | -- | -- | Yes | NSL | -- | -- | -- | Yes | NSL |
| Benzoic Acid | 12 | 120 J | 120 J | 1/12 | -- | -- | -- | Yes | NSL | -- | -- | -- | Yes | NSL |
| Benzyl Alcohol | 12 | 12 J | 12 J | 1/12 | -- | -- | -- | Yes | NSL | -- | -- | -- | Yes | NSL |
| bis(2-Ethylhexyl)phthalate | 12 | 11 J | 220 | 8/12 | -- | -- | -- | Yes | NSL | -- | -- | -- | Yes | NSL |
| Dibenzofuran | 12 | 2.4 J | 10 J | 2/12 | -- | -- | -- | Yes | NSL | -- | -- | -- | Yes | NSL |
| Diethylphthalate | 12 | 8 | 140 B | 2/12 | 100,000 | 0/2 | 0.0014 | No | <SL | -- | -- | -- | Yes | NSL |

**Table 4-1 Surface Soil (0 to 2 feet) Ecological Screening Results, Red Devil Mine Site SLERA**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | FoD | Soil Ecological Screening Levels and Hazard Quotients | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Plants | | | | | Soil Invertebrates | | | | |
| | | | | | Value[c] | FoE | HQ[e] | COPC | Rationale[f] | Value[d] | FoE | HQ[e] | COPC | Rationale[f] |
| Dimethylphthalate | 12 | 160 | 160 | 1/12 | -- | -- | -- | Yes | NSL | -- | -- | 200,000 | No | <SL |
| Hexachlorobenzene | 12 | 1.3 J | 1.3 J | 1/12 | -- | -- | -- | Yes | NSL | 1E+06 | 0/1 | 0.0000013 | No | <SL |
| Pentachlorophenol | 12 | 38 J | 38 J | 1/12 | 3,000 | 0/1 | 0.0127 | No | <SL | 6,000 | 0/1 | 0.00633333 | No | <SL |
| Phenol | 12 | 4.6 J | 4.6 J | 1/12 | 70,000 | 0/1 | 0.0001 | No | <SL | 30,000 | 0/1 | 0.0002 | No | <SL |

Key:
-- = not available or not applicable
B = present in blank
COPC = chemical of potential concern
Eco-SSL = Ecological Soil Screening Level
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence (number of detects > screening level / number of detects)
HPAH = high molecular weight PAH
HQ = hazard quotient
J = estimated value
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
PAH = polycyclic aromatic hydrocarbon
SL = Screening level
SLERA = screening level ecological risk assessment
µg/kg = micrograms per kilogram
Shading = HQ equals or exceeds 1, or no SL available. Chemical is a COPC.

Notes:
a = Detected chemicals only are listed.
b = For metals, 127 original site samples and 8 field duplicate samples. For PCB, 16 original site samples and 2 field duplicates. For PAHs and SVOCs, 11 original site samples and 1 field duplicate.
c = Eco-SSLs (www.epa.gov/ecotox/ecossl/) for arsenic, cadmium, cobalt, copper, lead, manganese, nickel, selenium, silver, and zinc. Chromium plant screening level is from Alloway (1984). Other plant screening levels are from Efroymson et al. (1997a). Acenaphthene value from Efroymson et al. (1997a) used for LPAH and HPAH sums.
d = Eco-SSLs (www.epa.gov/ecotox/ecossl/) except for SVOCs, which are from Efroymson et al. (1997b).
e = Hazard quotient (maximum detected concentration divided by screening level)
f = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level
NSL = no screening level available.
For No: < SLs = maximum detected concentration less than screening levels
MSC = Major soil constituent (of low toxicity; Gough et al. 1979, USEPA 2003).
NUT = Essential nutrient (USEPA 1989).

**Table 4-2 Sediment Ecological Screening Results for Red Devil Creek and Kuskokwim River Sediment, Red Devil Mine Site SLERA**

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | FoD | Sediment Ecological Screening Levels Value | Sediment Ecological Screening Levels Basis | FoE | HQ[c] | COPC | Rationale[d] |
|---|---|---|---|---|---|---|---|---|---|---|
| **Metals (mg/kg)** | | | | | | | | | | |
| Aluminum | 45 | 710 | 18400 | 45/45 | 58,000 | MacDonald et al. (1999). ERM *Hyalella* | 0/45 | 0.32 | No | <SL |
| Antimony | 45 | 0.237 J | 6360 J | 40/45 | 2.9 | MacDonald et al. (1999). PAETA, WA | 37/40 | 2193 | Yes | >SL |
| Arsenic | 45 | 0.57 J | 130000 | 45/45 | 9.8 | MacDonald et al. (2000). TEC. | 43/45 | 13265 | Yes | >SL |
| Barium | 45 | 4.12 | 1990 | 45/45 | -- | -- | -- | -- | Yes | NSL |
| Beryllium | 45 | 0.008 J | 0.9 | 43/45 | -- | -- | -- | -- | Yes | NSL |
| Cadmium | 45 | 0.017 J | 0.663 J | 32/45 | 0.99 | MacDonald et al. (2000). TEC. | 0/32 | 0.67 | No | <SL |
| Calcium | 45 | 1320 | 23400 | 45/45 | -- | -- | -- | -- | No | NUT |
| Chromium | 45 | 0.65 J | 47.4 J | 43/45 | 43.4 | MacDonald et al. (2000). TEC. | 1/43 | 1.1 | Yes | >SL |
| Cobalt | 45 | 0.369 | 50 | 45/45 | 50 | MacDonald et al. (1999). Criterion, Ontario. | 2/45 | 1.0 | Yes | =SL |
| Copper | 45 | 0.68 | 87.5 | 45/45 | 31.6 | MacDonald et al. (2000). TEC. | 14/45 | 2.8 | Yes | >SL |
| Iron | 45 | 19600 | 344000 | 45/45 | 21,200 | MacDonald et al. (1999). LEL, B.C. | 43/45 | 16 | Yes | >SL |
| Lead | 45 | 0.05 | 14.8 | 43/45 | 35.8 | MacDonald et al. (2000). TEC. | 0/43 | 0.41 | No | <SL |
| Magnesium | 45 | 990 | 11400 J | 45/45 | -- | -- | -- | -- | No | NUT |
| Manganese | 45 | 404 | 5410 | 45/45 | 460 | MacDonald et al. (1999). LEL, B.C. | 42/45 | 12 | Yes | >SL |
| Mercury | 45 | 0.169 J | 119 J | 45/45 | 0.18 | MacDonald et al. (2000). TEC. | 44/45 | 661 | Yes | >SL |
| Methylmercury | 33 | 0.0001 J | 0.0144 J | 32/33 | -- | -- | -- | -- | Yes | NSL |
| Nickel | 45 | 0.78 | 240 J | 45/45 | 22.7 | MacDonald et al. (2000). TEC. | 39/45 | 11 | Yes | >SL |
| Potassium | 45 | 510 J | 2870 J | 43/45 | -- | -- | -- | -- | No | NUT |
| Selenium | 45 | 0.16 J | 2.11 | 28/45 | 5 | MacDonald et al. (1999). Criterion, B.C. | 0/28 | 0.42 | No | <SL |
| Silver | 45 | 0.04 | 0.41 | 29/45 | 3.9 | MacDonald et al. (1999). PAETA, WA. | 0/29 | 0.11 | No | <SL |
| Sodium | 45 | 21.1 | 270 | 39/45 | -- | -- | -- | -- | No | NUT |
| Thallium | 45 | 0.011 J | 0.653 | 29/45 | -- | -- | -- | -- | Yes | NSL |
| Vanadium | 45 | 1.72 | 48.5 | 43/45 | -- | -- | -- | -- | Yes | NSL |
| Zinc | 45 | 1.2 J | 132 J | 45/45 | 121 | MacDonald et al. (2000). TEC. | 1/45 | 1.09 | Yes | >SL |
| **Semivolatile Organic Compounds (µg/kg)** | | | | | | | | | | |
| Benzo(b)fluoranthene | 2 | 1.5 J | 1.5 J | 1/2 | 27 | MacDonald et al (1999). TEL *Hyalella* 28-day test. | 0/45 | 0.06 | No | <SL |
| Benzyl Alcohol | 2 | 3.1 J | 3.1 J | 1/2 | 52 | Buchman (2008). AET, marine bivalve. | 0/45 | 0.06 | No | <SL |
| Diethyl Phthalate | 2 | 1.7 J | 1.7 J | 1/2 | 320 | MacDonald et al. (1999). Chronic EqP threshold. | 0/45 | 0.01 | No | <SL |
| Di-n-butyl Phthalate | 2 | 9 J | 9 J | 1/2 | 42 | MacDonald et al. (1999). PAETA, *Hyalella*, WA. | 0/45 | 0.21 | No | <SL |
| Pentachlorophenol | 2 | 22 J | 22 J | 1/2 | 40 | MacDonald et al. (1999). Ecotoxicological value. | 0/45 | 0.55 | No | <SL |
| Phenanthrene | 2 | 1.9 J | 2.1 J | 2/2 | 204 | MacDonald et al. (2000). TEC. | 0/45 | 0.01 | No | <SL |
| Phenol | 2 | 4.1 J | 4.1 J | 1/2 | 48 | MacDonald et al. (1999). PAETA, *Hyalella*, WA | 0/45 | 0.09 | No | <SL |

Key:

-- = Not available or not applicable
AET = Apparent effect threshold
B.C. = British Columbia, Canada
COPC = Chemical of potential concern
ERM = Effects range median
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
HPAH = High molecular weight PAHs
LEL = Low effect level
LPAH = Low molecular weight PAHs
PAETA = Probable apparent effect threshold approach
SL = Screening level
PAHs = Polycyclic aromatic hydrocarbons
TEC = Threshold effect concentration
TEL = Threshold effect level
WA = Washington State
[shaded] = HQ equals or exceeds 1, or no SL available. Chemical is a COPC.

Notes:

a = Detected analytes only are listed.
b = 42 original samples and 3 field duplicates
c = Hazard quotient (maximum concentration / screening level)
d = Rationale codes.

For Yes:
>SL = maximum detected concentration exceeds screening level
=SL = maximum concentration equals screening level
NSL = no screening level available.

For No:
NUT = Essential nutrient (EPA 1989).
<SL = maximum detected concentration less than screening level

## Table 4-3 Surface Water Ecological Screening Results for Unfiltered Samples from Red Devil Creek, Red Devil Mine Site SLERA

| Analyte[a] | Number of Samples[b] | Minimum Detected Concentration | Maximum Detected Concentration | FoD | Surface Water Chronic Ecological Screening Levels | | FoE | HQ[c] | COPC | Rationale[d] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Value | Basis | | | | |
| **Metals (µg/L)** | | | | | | | | | | |
| Aluminum | 22 | 6.5 J | 30.9 J | 13/22 | 87 | ADEC (2008) and EPA(2008) | 0/13 | 0.36 | No | <SL |
| Antimony | 22 | 1.3 | 184 | 22/22 | 30 | Suter and Tsao (1996), Tier II SCV | 12/22 | 6.1 | Yes | >SL |
| Arsenic | 22 | 0.8 | 1030 | 22/22 | 150 | ADEC (2008) and EPA(2008) | 2/22 | 6.9 | Yes | >SL |
| Barium | 22 | 20.6 | 103 | 22/22 | 4 | Suter and Tsao (1996), Tier II SCV | 22/22 | 26 | Yes | >SL |
| Beryllium | 22 | 0.009 J | 0.009 J | 1/22 | 0.66 | Suter and Tsao (1996), Tier II SCV | 0/1 | 0.01 | No | <SL |
| Cadmium | 22 | 0.005 J | 0.008 J | 3/22 | 0.25 | ADEC (2008) and EPA(2008) | 0/3 | 0.03 | No | <SL |
| Calcium | 22 | 8580 | 36000 | 22/22 | -- | -- | -- | -- | No | NUT |
| Chromium | 22 | 0.15 J | 0.57 | 13/22 | 74 | ADEC (2008) and EPA(2008) | 0/13 | 0.01 | No | <SL |
| Cobalt | 22 | 0.046 | 5.3 | 19/22 | 23 | Suter and Tsao (1996), Tier II SCV | 0/19 | 0.23 | No | <SL |
| Copper | 22 | 0.28 | 0.71 | 14/22 | 9 | ADEC (2008) and EPA(2008) | 0/14 | 0.08 | No | <SL |
| Iron | 22 | 118 | 2470 | 22/22 | 1,000 | ADEC (2008) and EPA(2008) | 3/22 | 2.5 | Yes | >SL |
| Lead | 22 | 0.008 J | 0.079 | 13/22 | 2.5 | ADEC (2008) and EPA(2008) | 0/13 | 0.03 | No | <SL |
| Magnesium | 22 | 4460 | 37100 | 22/22 | -- | -- | -- | -- | No | NUT |
| Manganese | 22 | 11.2 | 379 | 22/22 | 120 | Suter and Tsao (1996), Tier II SCV | 2/22 | 3.2 | Yes | >SL |
| Mercury | 21 | 0.00192 | 0.385 | 21/21 | 0.77 | ADEC (2008) and EPA(2008) | 0/21 | 0.50 | No | <SL |
| Mercury | 21 | 0.00192 | 0.385 | 21/21 | 0.012 | EPA (1986)e | 15/21 | 32 | Yes | >SL |
| Methylmercury | 21 | 0.00008 J | 0.00062 | 21/21 | 0.0028 | Suter and Tsao (1996), Tier II SCV | 0/22 | 0.22 | No | <SL |
| Nickel | 22 | 0.36 | 19.2 | 19/22 | 52 | ADEC (2008) and EPA(2008) | 0.19 | 0.37 | No | <SL |
| Potassium | 22 | 172 | 1210 | 13/22 | -- | -- | -- | -- | No | NUT |
| Selenium | 22 | 0.3 J | 0.5 J | 9/22 | 5 | ADEC (2008) and EPA(2008) | 0/9 | 0.10 | No | <SL |
| Silver | 22 | 0.008 J | 0.026 | 3/22 | 3.2 | ADEC (2008) and EPA(2008) | 0/3 | 0.008 | No | <SL |
| Sodium | 22 | 1440 | 12900 | 22/22 | -- | -- | -- | -- | No | NUT |
| Thallium | 22 | 0.007 J | 0.01 J | 2/22 | 12 | Suter and Tsao (1996), Tier II SCV | 0/2 | 0.001 | No | <SL |
| Vanadium | 22 | 0.1 J | 0.22 J | 13/22 | 20 | Suter and Tsao (1996), Tier II SCV | 0/13 | 0.011 | No | <SL |
| Zinc | 22 | 0.3 J | 2.1 | 9/22 | 118 | ADEC (2008) | 0/9 | 0.018 | No | <SL |
| **Semivolatile Organic Compounds (µg/L)** | | | | | | | | | | |
| Naphthalene | 20 | 0.68 J | 0.68 J | 1/20 | 12 | Suter and Tsao (1996), Tier II SCV | 0/1 | 0.06 | No | <SL |
| 1-Methylnaphthalene | 8 | 1.5 | 1.5 | 1/8 | 2.1 | Suter and Tsao (1996), Tier II SCV | 0/1 | 0.71 | No | <SL |
| 2-Methylnaphthalene | 20 | 1.2 J | 1.5 | 2/20 | 2.1 | Suter and Tsao (1996), Tier II SCV [f] | 0/2 | 0.71 | No | <SL |
| **Other Chemicals (mg/L)** | | | | | | | | | | |
| Alkalinity (Bicarbonate) | 19 | 72.4 | 243 | 19/19 | 20 | EPA (2009); minimum acceptable valueg | 0/19 | 12 | No | >SL |
| Chloride | 11 | 0.35 J | 0.6 | 11/11 | 230 | EPA (2009) | 0/11 | 0.00 | No | <SL |
| Fluoride | 19 | 0.04 J | 0.13 J | 12/19 | 0.3 | MacDonald et al. (1999), tentative criterion, B.C. | 0/12 | 0.43 | No | <SL |
| Sulfate | 19 | 8.63 | 28.5 | 19/19 | 100 | MacDonald et al. (1999), criterion max., B.C. | 0/19 | 0.29 | No | <SL |
| Total Suspended Solids | 19 | 3.6 | 3.6 | 1/19 | Narrative | EPA (2009) | 0/1 | -- | No | <SL |

Key:
- -- = Not available or not applicable
- ADEC = Alaska Department of Environmental Conservation
- B.C. = British Columbia
- COPC = chemical of potential concern
- FoD = frequency of detection (number of detects / number of samples)
- FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
- J = estimated quantity
- SCV = secondary chronic value
- SL = screening level
- SEPA = United States Environmental Protection Agency
- (grey shading) = HQ equals or exceeds 1 or no screening level available. Chemical is a COPC.

Notes:

a = Detected analytes only are listed.
b = 17 original samples and 3 field duplicates.
c = Hazard quotient (maximum concentration / screening level)
d = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level
NSL = no screening level available.
For No: NUT = Essential nutrient (EPA 1989).
<SL = maximum detected concentration less than screening level
e = Criterion derived using a bioconcentration factor of 81,700 for methylmercury for fathead minnow. Assumes all mercury is present in water as methylmercury.
f = For 1-methylnaphthalene
g = Criterion reflects a minimum level of alkalinity to be present in surface water. Alkalinity levels greater than the criterion are desireable.

**Table 4-3b  Maximum Chemical Concentrations in Scuplin Whole-Body Samples from Red Devil Creek Compared With Fish Tissue Screening Concentrations**

| Analyte | Maximum Detected Concentration (mg/kg wet weight)[a] | | Tissue Screening Concentration (mg/kg wet weight)[b] | FoE | HQ[c] | COPC | Rationale[d] |
|---|---|---|---|---|---|---|---|
| Antimony | 38.1 | | -- | -- | -- | Yes | NSL |
| Arsenic | 24.1 | | 1.7 | 18/21 | 14 | Yes | >SL |
| Barium | 5.40 | | -- | -- | -- | Yes | NSL |
| Beryllium | ND[e] | | -- | -- | -- | No | ND |
| Cadmium | 0.103 | | 0.15 | 0/11 | 0.7 | No | <SL |
| Chromium | 2.431 | | 0.69 | 1/21 | 3.5 | Yes | >SL |
| Copper | 2.263 | J- | 3.1 | 0/21 | 0.7 | No | <SL |
| Lead | 0.079 | | 2.2 | 0/13 | 0.04 | No | <SL |
| Manganese | 21.3 | | -- | -- | -- | Yes | >SL |
| Mercury | 3.70 | | 0.46 | 13/21 | 8.0 | Yes | >SL |
| Methylmercury | 0.312 | | 0.3 - 0.7 | 1/2 | 1.0 | Yes | = SL |
| Nickel | 0.263 | | 18.4 | 0/21 | 0.01 | No | <SL |
| Selenium | 2.98 | | 1.1 | 16/21 | 2.7 | Yes | >SL |
| Vanadium | 0.40 | | -- | -- | -- | Yes | NSL |
| Zinc | 35.4 | | 27 | 7/21 | 1.3 | Yes | >SL |

Key:
-- not available or not applicable.
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
HQ = hazard quotient
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.
SL = screening level

Notes:
a = See Table 4-6.
b = Dyer et al. (2000), except for methylmercury, which is from Sandheinrich and Weiner (2011).
c = Hazard quotient (maximum concentration / screening level)
d = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds SL
= SL = maximum detected concentration equals SL
NSL = no screening level available.
For No: ND = not detected
<SL = maximum detected concentration less than SL
e = Beryllium method detection limits = 0.025 mg/kg wet weight.

**Table 4-4 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site**

| | Number of Samples[a] | Minimum Concentration (mg/kg dry weight) | Maximum Concentration (mg/kg dry weight) | Frequency of Detection |
|---|---|---|---|---|
| **Green Alder Bark** | | | | |
| Aluminum | 9 | 3.7 | 24.2 | 8/9 |
| Antimony | 9 | 0.165 J | 3.35 J | 8/9 |
| Arsenic | 9 | 0.06 | 0.91 | 7/9 |
| Barium | 9 | 2.35 | 203 | 8/9 |
| Beryllium | 9 | 0.005 J | 0.015 J | 4/9 |
| Cadmium | 9 | 0.014 J | 0.129 | 6/9 |
| Calcium | 9 | 4560 | 10800 | 8/9 |
| Chromium | 9 | 0.3 J | 1.4 J | 3/9 |
| Cobalt | 9 | 0.064 | 0.528 | 8/9 |
| Copper | 9 | 4.33 | 6.64 | 8/9 |
| Iron | 9 | 17.6 | 34.9 | 8/9 |
| Lead | 9 | 0.06 | 0.113 | 8/9 |
| Magnesium | 9 | 529 | 967 | 8/9 |
| Manganese | 9 | 91.2 | 1140 | 8/9 |
| Mercury | 9 | 0.017 J | 0.289 J | 8/9 |
| Methylmercury | 5 | 0.0037 U | 0.004 U | 0/5 |
| Nickel | 9 | 0.72 | 4.15 | 8/9 |
| Potassium | 9 | 1530 | 2610 | 8/9 |
| Selenium | 9 | 0.22 J | 0.22 J | 1/9 |
| Silver | 9 | 0.016 | 0.193 | 2/9 |
| Sodium | 9 | 9.8 | 17 | 8/9 |
| Thallium | 9 | 0.006 J | 0.03 | 4/9 |
| Vanadium | 9 | 0.03 J | 0.07 | 8/9 |
| Zinc | 9 | 35.9 J | 108 J | 8/9 |
| **Blueberry Leaves and Stems** | | | | |
| Aluminum | 2 | 59.7 | 64.6 | 2/2 |
| Antimony | 2 | 0.096 J | 0.131 J | 2/2 |
| Arsenic | 2 | 0.08 J | 0.15 J | 2/2 |
| Barium | 2 | 50.4 | 68 | 2/2 |
| Beryllium | 2 | 0.003 U | 0.003 J | 1/2 |
| Cadmium | 2 | 0.332 | 1.2 | 2/2 |
| Calcium | 2 | 2400 | 2430 | 2/2 |
| Chromium | 2 | 0.2 U | 0.2 J | 1/2 |
| Cobalt | 2 | 0.035 | 0.099 | 2/2 |
| Copper | 2 | 3.58 | 5.97 | 2/2 |
| Iron | 2 | 20.3 | 25.6 | 2/2 |
| Lead | 2 | 0.061 | 0.067 | 2/2 |
| Magnesium | 2 | 902 | 1120 | 2/2 |
| Manganese | 2 | 1430 | 1630 | 2/2 |
| Mercury | 2 | 0.023 J | 0.034 J | 2/2 |
| Methylmercury | 2 | 0.004 U | 0.004 U | 0/2 |
| Nickel | 2 | 1.89 | 6.68 | 2/2 |
| Potassium | 2 | 3930 | 4340 | 2/2 |
| Selenium | 2 | 0.15 U | 0.15 U | 2/2 |
| Silver | 2 | 0.008 U | 0.008 U | 2/2 |
| Sodium | 2 | 12.2 J | 12.9 J | 2/2 |
| Thallium | 2 | 0.005 J | 0.006 J | 2/2 |
| Vanadium | 2 | 0.03 J | 0.03 J | 2/2 |
| Zinc | 2 | 31.6 J | 42.6 J | 2/2 |
| **Spruce Needles** | | | | |
| Aluminum | 9 | 5.1 | 172 | 8/9 |
| Antimony | 9 | 0.20 J | 15.1 J | 7/9 |
| Arsenic | 9 | 0.11 J | 11.1 | 7/9 |
| Barium | 9 | 4.16 | 85.3 | 7/9 |
| Beryllium | 9 | 0.008 J | 0.008 J | 1/9 |
| Cadmium | 9 | 0.01 J | 0.191 | 7/9 |

## Table 4-4 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site

| | Number of Samples[a] | Minimum Concentration (mg/kg dry weight) | Maximum Concentration (mg/kg dry weight) | Frequency of Detection |
|---|---|---|---|---|
| Calcium | 9 | 3320 | 9920 | 8/9 |
| Chromium | 9 | 0.4 J | 1.3 J | 5/9 |
| Cobalt | 9 | 0.05 | 0.303 | 8/9 |
| Copper | 9 | 0.93 | 4.42 | 8/9 |
| Iron | 9 | 20.1 | 206 | 8/9 |
| Lead | 9 | 0.009 | 0.466 | 8/9 |
| Magnesium | 9 | 548 | 958 | 8/9 |
| Manganese | 9 | 130 | 2990 | 8/9 |
| Mercury | 9 | 0.03 | 5.64 | 8/9 |
| Methylmercury | 5 | 0.0037 U | 0.004 U | 0/5 |
| Nickel | 9 | 0.67 | 6.35 | 8/9 |
| Potassium | 9 | 3450 | 7740 | 8/9 |
| Selenium | 9 | 0.15 U | 0.15 U | 0/9 |
| Silver | 9 | 0.016 J | 0.114 | 6/9 |
| Sodium | 9 | 4.1 J | 24.8 J | 8/9 |
| Thallium | 9 | 0.005 J | 0.021 J | 2/9 |
| Vanadium | 9 | 0.03 J | 0.47 | 7/9 |
| Zinc | 9 | 13.9 | 53.2 J | 8/9 |
| **Pond Vegetation** | | | | |
| Aluminum | 5 | 8.3 | 94.2 | 4/5 |
| Antimony | 5 | 4.92 J | 97.4 J | 4/5 |
| Arsenic | 5 | 32.1 | 309 | 4/5 |
| Barium | 5 | 18.2 | 36.2 | 4/5 |
| Beryllium | 5 | 0.003 J | 0.006 J | 4/5 |
| Cadmium | 5 | 0.009 J | 0.22 | 4/5 |
| Calcium | 5 | 13300 | 15700 | 4/5 |
| Chromium | 5 | 0.2 J | 0.6 J | 2/5 |
| Cobalt | 5 | 0.308 | 0.886 | 4/5 |
| Copper | 5 | 3.4 | 9.62 | 4/5 |
| Iron | 5 | 124 | 282 | 4/5 |
| Lead | 5 | 0.32 | 1.18 | 4/5 |
| Magnesium | 5 | 6340 | 13400 | 4/5 |
| Manganese | 5 | 46.8 | 199 | 4/5 |
| Mercury | 5 | 0.78 J | 5.28 J | 4/5 |
| Methylmercury | 5 | 0.0069 J | 0.0069 J | 1/1 |
| Nickel | 5 | 1.11 | 3.21 | 4/5 |
| Potassium | 5 | 15400 | 39500 | 4/5 |
| Selenium | 5 | 0.81 | 0.81 | 1/5 |
| Silver | 5 | 0.008 U | 0.008 U | 0/5 |
| Sodium | 5 | 52.5 | 377 | 4/5 |
| Thallium | 5 | 0.017 J | 0.083 | 4/5 |
| Vanadium | 5 | 0.05 J | 0.29 | 4/5 |
| Zinc | 5 | 36 J | 55.7 J | 4/5 |

Key:
-- = Not available or not applicable
J = estimated value
U = undetected (reported value is method detection limit)

Notes:
a = Number of original site samples and field duplicates.
Green alder bark: 8 original site samples and 1 field duplicate.
Blueberry leaves and stems: 2 original site samples and 0 field duplicates.
Blueberry fruit: 0 original site samples and 0 field duplicates.
Spruce needles: 8 original site samples and 1 field duplicate.
Pond vegetation: 4 original site samples and 1 field duplicate.

**Table 4-5 Summary of 2010 Benthic Macroinvertebrate Composite Sample Data for Red Devil Creek, Red Devil Mine Site SLERA**

| Analyte | August 2010 Samples[a] | | | | June 2010 Samples[b] | | | |
|---|---|---|---|---|---|---|---|---|
| | Number of Samples | Minimum Detected Concentration (mg/kg wet weight) | Maximum Detected Concentration (mg/kg wet weight) | Frequency of Detection | Number of Samples | Minimum Detected Concentration (mg/kg wet weight) | Maximum Detected Concentration (mg/kg wet weight) | Frequency of Detection |
| Aluminum | -- | -- | -- | -- | 3 | 118.4 | **125** | 3/3 |
| Antimony | -- | -- | -- | -- | 3 | 18.95 | **21.44** | 3/3 |
| Arsenic | -- | -- | -- | -- | 3 | 81.24 | **126.44** | 3/3 |
| Barium | -- | -- | -- | -- | 3 | 4.84 | **6.61** | 3/3 |
| Beryllium | -- | -- | -- | -- | 3 | ND[c] | ND[c] | 0/3 |
| Boron | -- | -- | -- | -- | 3 | 0.67 J+ | **1.011** J+ | 3/3 |
| Cadmium | -- | -- | -- | -- | 3 | 0.082 | **0.166** | 3/3 |
| Calcium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Chromium | -- | -- | -- | -- | 3 | 0.327 | **0.441** | 3/3 |
| Cobalt | -- | -- | -- | -- | 3 | -- | -- | -- |
| Copper | -- | -- | -- | -- | 3 | 6.564 | **12.405** | 3/3 |
| Iron | -- | -- | -- | -- | 3 | 761.3 J- | **974** J- | 3/3 |
| Lead | -- | -- | -- | -- | 3 | 0.131 | **0.154** | 3/3 |
| Magnesium | -- | -- | -- | -- | 3 | 162 | **376** | 3/3 |
| Manganese | -- | -- | -- | -- | 3 | 27.84 | **50.8** | 3/3 |
| Mercury | -- | -- | -- | -- | 3 | 1.60 | **2.38** | 3/3 |
| Methylmercury | 3 | 0.0587 | **0.131** | 3/3 | 3 | 0.0238 | 0.0594 | 3/3 |
| Molybdenum | -- | -- | -- | -- | 3 | 0.1 | **0.19** | 3/3 |
| Nickel | -- | -- | -- | -- | 3 | 0.557 | **1.409** | 3/3 |
| Potassium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Selenium | -- | -- | -- | -- | 3 | 1.002 | **4.046** | 3/3 |
| Silver | -- | -- | -- | -- | 3 | -- | -- | -- |
| Sodium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Strontium | -- | -- | -- | -- | 3 | 1.3 J+ | **2.2** J+ | 3/3 |
| Thallium | -- | -- | -- | -- | 3 | -- | -- | -- |
| Vanadium | -- | -- | -- | -- | 3 | 0.40 | **0.47** | 3/3 |
| Zinc | -- | -- | -- | -- | 3 | 22.6 J- | **44.9** J- | 3/3 |

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK.

Key:
-- (double dash) = not analyzed.
BLM = Bureau of Land Management
**Bold** = maximum detected concentration across both sampling events
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.

Notes:
a = Ephemeroptera, Heptageniidae, *Cinygmula* (mayfly) composite samples with 125 to 176 individuals per sample
b = Ephemeroptera, Baetidae, *Baetis* (mayfly) composite samples with 270 to 425 individuals per sample
c = Beryllium method detection limits = 0.025 mg/kg wet weight.

## Table 4-6 Summary of 2010 Sculpin Data from Red Devil Creek, Red Devil Mine Site SLERA

| Analyte | August 2010 Samples: Number of Samples | August 2010 Samples: Minimum Detected Concentration (mg/kg wet weight) | August 2010 Samples: Maximum Detected Concentration (mg/kg wet weight) | August 2010 Samples: Frequency of Detection | June 2010 Samples: Number of Samples | June 2010 Samples: Minimum Detected Concentration (mg/kg wet weight) | June 2010 Samples: Maximum Detected Concentration (mg/kg wet weight) | June 2010 Samples: Frequency of Detection |
|---|---|---|---|---|---|---|---|---|
| Aluminum | 12 | 11.7 | **72.5** | 12/12 | 9 | 3.6 | 20.9 | 9/9 |
| Antimony | 12 | 6.51 | **38.1** | 12/12 | 9 | 0.40 | 4.04 | 9/9 |
| Arsenic | 12 | 6.86 | **24.1** | 12/12 | 9 | 1.10 | 4.49 | 9/9 |
| Barium | 12 | 2.83 | **5.40** | 12/12 | 9 | 2.01 | 4.35 | 9/9 |
| Beryllium | 12 | ND[b] | ND[b] | 0/12 | 9 | ND[b] | ND[b] | 0/9 |
| Boron | 12 | 0.031 | 0.088 | 5/12 | 9 | 0.142 J+ | **0.843** J | 9/9 |
| Cadmium | 12 | 0.029 | 0.056 | 5/12 | 9 | 0.027 | **0.103** | 6/9 |
| Calcium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Chromium | 12 | 0.038 | 0.188 | 12/12 | 9 | 0.028 | **2.431** | 9/9 |
| Cobalt | -- | -- | -- | -- | 9 | -- | -- | -- |
| Copper | 12 | 0.72 | 1.164 | 12/12 | 9 | 0.27 J- | **2.263** J- | 9/9 |
| Iron | 12 | 63.7 | **184** | 12/12 | 9 | 18.9 J- | 61 J- | 9/9 |
| Lead | 12 | 0.027 | **0.079** | 11/12 | 9 | 0.025 J | 0.026 | 2/9 |
| Magnesium | 12 | 280 | 368 | 12/12 | 9 | 251 | **423** | 9/9 |
| Manganese | 12 | 6.65 | **21.3** | 12/12 | 9 | 8.44 | 16.0 | 9/9 |
| Mercury | 12 | 0.68 | **3.70** | 12/12 | 9 | 0.05 | 0.63 | 9/9 |
| Methylmercury | 1 | 0.16 | 0.16 | 1/1 | 1[a] | 0.312 | **0.312** | 1/1 |
| Molybdenum | 12 | 0.028 | **0.038** | 7/12 | 9 | 0.03 | 0.03 | 1/9 |
| Nickel | 12 | 0.083 | **0.263** | 12/12 | 9 | 0.039 | 0.113 | 9/9 |
| Potassium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Selenium | 12 | 1.53 | **2.98** | 12/12 | 9 | 0.834 | 1.43 | 9/9 |
| Silver | -- | -- | -- | -- | 9 | -- | -- | -- |
| Sodium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Strontium | 12 | 10.6 | 30.0 | 12/12 | 9 | 15.5 J+ | **32.8** J+ | 9/9 |
| Thallium | -- | -- | -- | -- | 9 | -- | -- | -- |
| Vanadium | 12 | 0.15 | 0.32 | 12/12 | 9 | 0.10 | **0.40** | 9/9 |
| Zinc | 12 | 20.6 | **35.4** | 12/12 | 9 | 17.1 J- | 30.2 J- | 9/9 |

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK.

Key:
-- (double dash) = not analyzed.
BLM = Bureau of Land Management
**Bold** = maximum detected concentration across both sampling events.
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.

Notes:
a = Composite sample. In June 2010, methylmercury was measured only in a composite sample of three sculpin.
b = Beryllium method detection limits = 0.025 mg/kg wet weight.

## Table 4-7 Exposure Parameters for Wildlife Receptors, Red Devil Mine Site SLERA

| Species | Assumed Diet | Soil or Sediment Ingestion (kg/d) dry | Surface Water Ingestion (L/day) | Food Ingestion Rate (kg/d) wet | Percent Water in Diet | Food Ingestion Rate (kg/d) dry | Body Weight (kg) |
|---|---|---|---|---|---|---|---|
| **Terrestrial Wildlife** | | | | | | | |
| American Robin[a] | 100% soil invertebrates | 0.00019 | 0.011 | 0.093 | 80% | 0.0186 | 0.077 |
| Masked Shrew[b] | 100% soil invertebrates | 0.00011 | 0.0011 | -- | -- | 0.0021 | 0.0064 |
| Spruce Grouse[c] | 100% conifer foliage | 0.0056 | 0.038 | -- | -- | 0.06 | 0.53 |
| Tundra Vole[b] | 100% herbaceous plants | 0.0002 | 0.0063 | -- | -- | 0.0085 | 0.047 |
| Northern Shrike[d] | 100% small mammals | 0 | 0.0095 | -- | -- | 0.0139 | 0.0656 |
| Least Weasel[e] | 100% small mammals | 0 | 0.0053 | -- | -- | 0.0048 | 0.039 |
| **Aquatic-Dependent Wildlife** | | | | | | | |
| Common Snipe[b, h] | 100% benthic invertebrates | 0.0016 | 0.014 | 0.047 | 68% | 0.015 | 0.116 |
| Beaver[f] | 100% alder bark | 0.0037 | 1.76 | -- | -- | 0.186 | 24.5 |
| Green Winged Teal[b] | 100% pond vegetation | 0.001 | 0.027 | -- | -- | 0.053 | 0.32 |
| Belted Kingfisher[g] | 100% forage fish | 0 | 0.016 | 0.075 | 68% | 0.024 | 0.148 |
| Mink[g] | 100% forage fish | 0 | 0.099 | 0.137 | 68% | 0.044 | 1 |

Key:
-- = not applicable
kg = kilogram
kg/d = kilograms per day
L/d = liters per day
SLERA = screening level ecological risk assessment

Notes:
a. Sample and Suter (1994).
b. Exponent (2007).
c. Exponent (2007) for willow ptarmigan.
d. Dunning (1993) for body weight. Food ingestion rate calculated from body weight using allometric relationship for passerine birds from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
e. EPA (1993a) for body weight. Food ingestion rate calculated from body weight using allometric relationship for placental mammals from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
f. Body weight from www.Alaskan-Adventures.com (accessed 6-7-11). Food and water ingestion rates calculated from body weight using allometric relationships from Sample et al. (1996). Soil ingestion rate assumed to be 2% of food ingestion rate.
g. Sample and Suter (1994).
h. Food moisture content of 68% based on EPA (1999) for carnivores. Wet food Ingestion rate = dry food ingestion rate / (1- food moisture content).

## Table 4-8 Data Used to Estimate Exposure Point Concentrations for Calculating Screening Level Exposure Estimates for Wildlife

| | Exposure Point Concentration | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Maximum Measured Chemical Concentration | | | | | | | | | | Modeled Concentration[a] | |
| | | | Sediment | | | | | | | | | |
| Receptor | RDC Surface Water | Surface Soil | RDC and KR | Settling Ponds | Spruce Needles[b] | Blueberry Stems and Leaves[b] | Green Alder Bark[b] | Settling Pond Plants[b] | Sculpin[b] | Mayfly[b] | Earthworm | Small Mammal |
| **Terrestrial Wildlife** | | | | | | | | | | | | |
| American Robin | X | X | | | | | | | | | X | |
| Masked Shrew | X | X | | | | | | | | | X | |
| Spruce Grouse | X | X | | | X | | | | | | | |
| Tundra Vole | X | X | | | | X | | | | | | |
| Northern Shrike | X | | | | | | | | | | | X |
| Least Weasel | X | | | | | | | | | | | X |
| **Aquatic-Dependent Wildlife** | | | | | | | | | | | | |
| Common Snipe | X | | X | | | | | | | X | | |
| Beaver | X | X | | | | | X | | | | | |
| Green Winged Teal | | | | X | | | | X | | | | |
| Belted Kingfisher | X | | | | | | | | X | | | |
| Mink | X | | | | | | | | X | | | |

Key:
KR = Kuskokwim River
RDC = Red Devil Creek

Notes:
a = Based on maximum surface soil concentration. For chemicals with no available model, the chemical concentration in earthworms and small mammals was set equal to the maximum surface soil chemical concentration.
b = If a chemical was detected in soil or sediment but not analyzed for in biota, the biota chemical concentration was assumed to be equal to the maximum soil or sediment chemical concentration.

**Table 4-9 American Robin and Masked Shrew Exposure Point Concentrations, Red Devil Mine Site SLERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Surface Soil EPC[c, d] | Soil-to-Earthworm Bioaccumulation Equation[e] | Earthworm EPC[d] |
|---|---|---|---|---|
| **Polychlorinated Biphenyls (PCBs)** | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | -- | 0.078 | $\ln(C_e) = 1.361 * \ln(C_s) – 1.410$ | 0.011 |
| **Metals** | | | | |
| Antimony | 184 | 23300 | $C_e = C_s$ | 23300 |
| Arsenic | 1,030 | 9880 | $\ln(C_e) = 0.706 * \ln(C_s) – 1.421$ | 160 |
| Barium | 103 | 1710 | $C_e = 0.091 * C_s$ | 156 |
| Beryllium | 0.009 | 1.3 | $C_e = 0.045 * C_s$ | 0.059 |
| Cadmium | 0.008 | 1.3 | $\ln(C_e) = 0.795 * \ln(C_s) + 2.114$ | 10.2 |
| Chromium | 0.57 | 101 | $C_e = 0.306 * C_s$ | 30.9 |
| Cobalt | 5.3 | 38.8 | $C_e = 0.122 * C_s$ | 4.7 |
| Copper | 0.71 | 139 | $C_e = 0.5 15 * C_s$ | 71.6 |
| Lead | 0.079 | 3090 | $\ln(C_e) = 0.807 * \ln(C_s) – 0.218$ | 527 |
| Manganese | 379 | 4230 | $\ln(C_e) = 0.682 * \ln(C_s) – 0.809$ | 132 |
| Mercury | 0.385 | 1620 | $\ln(C_e) = 0.118 * \ln(C_s) – 0.684$ | 1.21 |
| Methylmercury | 0.00062 | -- | 3 x (blueberry stem/leaf concentration) | 0.006 |
| Nickel | 19.2 | 97 | $C_e = 1.059 * C_s$ | 103 |
| Selenium | 0.5 | 0.42 | $\ln(C_e) = 0.733 * \ln(C_s) – 0.075$ | 0.49 |
| Silver | 0.026 | 0.123 | $C_e = 2.045 * C_s$ | 0.25 |
| Thallium | 0.01 | 0.071 | $C_e = C_s$ | 0.071 |
| Vanadium | 0.22 | 51.9 | $C_e = 0.042 * C_s$ | 2.18 |
| Zinc | 2.1 | 386 | $\ln(C_e) = 0.328 * \ln(C_s) + 4.449$ | 603 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | |
| HPAH sum (NDs = 0.5 MDL) | 3.6 | 109 | $C_e = 2.6 * C_s$ | 282 |
| LPAH sum (NDs = 0.5 MDL) | 2.9 | 417 | $C_e = 3.0 * C_s$ | 1252 |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | |
| 4-Bromophenyl Phenyl Ether | 0.21 | 1.9 | $C_e = C_s$ | 1.9 |
| 4-Methylphenol | 0.26 | 4.9 | $C_e = C_s$ | 4.9 |
| Benzoic Acid | 0.30 | 120 | $C_e = C_s$ | 120 |
| Benzyl Alcohol | 1.0 | 12 | $C_e = C_s$ | 12 |
| Bis(2-ethylhexyl)phthalate | 0.95 | 220 | $C_e = C_s$ | 220 |
| Dibenzofuran | 0.24 | 10 | $C_e = C_s$ | 10 |
| Diethylphthalate | 0.29 | 140 | $C_e = C_s$ | 140 |
| Dimethylphthalate | 0.27 | 160 | $C_e = C_s$ | 160 |
| Hexachlorobenzene | 0.32 | 1.3 | $C_e = C_s$ | 1.3 |
| Pentachlorophenol | 1.25 | 38 | $C_e = C_s$ | 38 |
| Phenol | 0.26 | 4.6 | $C_e = C_s$ | 4.6 |

Key:
-- = not analyzed
$C_e$ = chemical concentration in earthworm
$C_s$ = chemical concentration in soil
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyls
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
µg/kg = micrograms per kilogram
µg/L = micrograms per liter

Notes:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

b. Maximum surface water concentration from Table 4-3. HPAHs, 4-bromophenyl phenyl ether, 4-methylphenol, benzoic acid, benzyl alcohol, bis(2-ethylhexyl)phthalate, dibenzofuran, diethylphthalate, hexachlorobenzene, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the MDL in surface water.

c. Maximum surface soil concentration from Table 4-1.

d. mg/kg for metals and µg/kg for PCBs and SVOCs.

e. Soil-to-earthworm bioacumulation equations from EPA (2005a), except for PCBs and nickel, which are from Sample et al. (1998a). For chemicals with no available model, the chemical concentration in earthworms was set equal to the maximum surface soil chemical concentration.

**Table 4-10 Spruce Grouse, Tundra Vole, and Beaver Exposure Point Concentrations, Red Devil Mine Site SLERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Surface Soil EPC[c, d] | Spruce Needles[e] | Blueberry Stems and Leaves[e] | Alder Bark[e] |
|---|---|---|---|---|---|
| **Polychlorinated Biphenyls** | | | | | |
| Sum of Aroclors (NDs = 0.5 MDL) | -- | 0.078 | 0.078 | 0.078 | 0.078 |
| **Metals** | | | | | |
| Antimony | 184 | 23300 | 15.1 | 0.131 | 3.35 |
| Arsenic | 1,030 | 9880 | 11.1 | 0.15 | 0.91 |
| Barium | 103 | 1710 | 85.3 | 68.0 | 203 |
| Beryllium | 0.009 | 1.3 | 0.008 | 0.003 | 0.015 |
| Cadmium | 0.008 | 1.3 | 0.19 | 1.20 | 0.13 |
| Chromium | 0.57 | 101 | 1.30 | 0.20 | 1.40 |
| Cobalt | 5.3 | 38.8 | 0.303 | 0.10 | 0.53 |
| Copper | 0.71 | 139 | 4.42 | 5.97 | 6.64 |
| Lead | 0.079 | 3090 | 0.47 | 0.067 | 0.113 |
| Manganese | 379 | 4230 | 2990 | 1630 | 1140 |
| Mercury | 0.385 | 1620 | 5.64 | 0.034 | 0.29 |
| Methylmercury | 0.00062 | -- | 0.002 | 0.002 | 0.002 |
| Nickel | 19.2 | 97 | 6.35 | 6.68 | 4.15 |
| Selenium | 0.5 | 0.42 | 0.075 | 0.075 | 0.22 |
| Silver | 0.026 | 0.123 | 0.114 | 0.004 | 0.193 |
| Thallium | 0.01 | 0.071 | 0.021 | 0.006 | 0.03 |
| Vanadium | 0.22 | 51.9 | 0.47 | 0.03 | 0.07 |
| Zinc | 2.1 | 386 | 53.2 | 42.6 | 108 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 3.6 | 109 | 109 | 109 | 109 |
| LPAH sum (NDs = 0.5 MDL) | 2.9 | 417 | 417 | 417 | 417 |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | |
| 4-Bromophenyl Phenyl Ether | 0.21 | 1.9 | 1.9 | 1.9 | 1.9 |
| 4-Methylphenol | 0.26 | 4.9 | 4.9 | 4.9 | 4.9 |
| Benzoic Acid | 0.30 | 120 | 120 | 120 | 120 |
| Benzyl Alcohol | 1.0 | 12 | 12 | 12 | 12 |
| Bis(2-ethylhexyl)phthalate | 0.95 | 220 | 220 | 220 | 220 |
| Dibenzofuran | 0.24 | 10 | 10 | 10 | 10 |
| Diethylphthalate | 0.29 | 140 | 140 | 140 | 140 |
| Dimethylphthalate | 0.27 | 160 | 160 | 160 | 160 |
| Hexachlorobenzene | 0.32 | 1.3 | 1.3 | 1.3 | 1.3 |
| Pentachlorophenol | 1.25 | 38 | 38 | 38 | 38 |
| Phenol | 0.26 | 4.6 | 4.6 | 4.6 | 4.6 |

Key:
-- = not available
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weigjht PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
PAH = polycyclic aromatic hydrocarbon
SLERA = screening level ecological risk assessment
SVOCs = semivolatile organic compounds
µg/kg = micrograms per kilogram
µg/L = micrograms per liter

Notes:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.
b. Maximum surface water concentration from Table 4-3. HPAHs, 4-bromophenyl phenyl ether, 4-methylphenol, benzoic acid, benzyl alcohol, bis(2-ethylhexyl)phthalate, dibenzofuran, diethylphthalate, hexachlorobenzene, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the MDL in surface water.
c. Maximum surface soil concentration from Table 4-1.
d. mg/kg for metals and µg/kg for PCBs and SVOCs.
e. Maximum detected concentration or one-half maximum detection limit (if not detected in all samples). See Table 4-4 for summary of 2011 vegetation data. Aroclor 1260 and several SVOCs were detected in soil but not analyzed for in vegetation. For these chemicals, the vegetation chemical concentration was assumed to be equal to the maximum soil chemical concentration.

## Table 4-11 Green-Winged Teal Exposure Point Concentrations, Red Devil Mine Site SLERA

| Analyte[a] | Surface Water EPC (µg/L)[b] | Settling Pond "Sediment" EPC[c, d] | Settling Pond Vegetation EPC | |
|---|---|---|---|---|
| | | | Value[d] | Basis |
| **Metals** | | | | |
| Antimony | 184 | 1430 | 97.4 | Maximum measured concentration (Table 4-5). |
| Arsenic | 1,030 | 9880 | 309 | Maximum measured concentration (Table 4-5). |
| Barium | 103 | 145 | 36.2 | Maximum measured concentration (Table 4-5). |
| Beryllium | 0.009 | 0.8 | 0.006 | Maximum measured concentration (Table 4-5). |
| Cadmium | 0.008 | 0.06 | 0.22 | Maximum measured concentration (Table 4-5). |
| Chromium | 0.57 | 19 | 0.6 | Maximum measured concentration (Table 4-5). |
| Cobalt | 5.3 | 18.1 | 0.886 | Maximum measured concentration (Table 4-5). |
| Copper | 0.71 | 73 | 9.62 | Maximum measured concentration (Table 4-5). |
| Lead | 0.079 | 198 | 1.18 | Maximum measured concentration (Table 4-5). |
| Manganese | 379 | 1090 | 199 | Maximum measured concentration (Table 4-5). |
| Mercury | 0.385 | 127 | 5.28 | Maximum measured concentration (Table 4-5). |
| Methylmercury | 0.00062 | -- | 0.0069 | Maximum measured concentration (Table 4-5). |
| Nickel | 19.2 | 58 | 3.21 | Maximum measured concentration (Table 4-5). |
| Selenium | 0.5 | 1.75 | 0.81 | Maximum measured concentration (Table 4-5). |
| Silver | 0.026 | 0.12 | 0.004 | One-half method detection limit (Table 4-5). |
| Thallium | 0.01 | 0.75 | 0.083 | Maximum measured concentration (Table 4-5). |
| Vanadium | 0.22 | 25.3 | 0.29 | Maximum measured concentration (Table 4-5). |
| Zinc | 2.1 | 112 | 55.7 | Maximum measured concentration (Table 4-5). |
| **Semivolatile Organic Compounds (SVOCs)** | | | | |
| Bis(2-ethylhexyl)phthalate | 0.5 | 220 | 220 | Not analyzed in pond vegetation. See note e. |

Key:
-- = Not analyzed.
EPC = Exposure point concentration
MDL = method detection limit
mg/kg = milligrams per kilogram
SVOC = Semivolatile organic compound.
SLERA = Screening level ecological risk assessment.
µg/kg = micrograms per kilogram
µg/L = micrograms per kilogram

Notes:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per USEPA guidance (USEPA 1989, 2003). SVOCs detected in pond surface soil are listed.
b. Maximum surface water concentrations for Red Devil Creek from Table 4-3. Surface water was not present in the settling ponds during sampling activities. Water concentration for bis(2-ethylhexyl)phthalate is one-half method detection limit (1 ug/L).
c. Maximum concentration from three original surface soil samples (10MP32SS, 10MP34SS, and 10MP36SS) and one field duplicate surface soil sample (10MP84SS) collected from the settling ponds. Cadmium, selenium, silver and thallium were undetected in pond surface soil so one-half of the MDL was used as the EPC.
d. mg/kg for metals and µg/kg for SVOCs.
e. The concentration in vegetation was assumed to equal the maximum surface soil concentration.

**Table 4-12 Northern Shrike and Least Weasel Exposure Point Concentrations, Red Devil Mine Site SLERA**

| Analyte[a] | Surface Water EPC (µg/L)[b] | Surface Soil EPC[c, d] | Soil- or Diet-to-Small Mammal Bioaccumulation Equation[e] | Small Mammal EPC[d] |
|---|---|---|---|---|
| **Polychlorinated Biphenyls (PCBs)** | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | -- | 0.078 | $C_m = C_s$ | 0.078 |
| **Metals** | | | | |
| Antimony | 184 | 23300 | $C_m = 0.001 * 50 * C_d$ | 0.007 |
| Arsenic | 1,030 | 9880 | $\ln(C_m) = 0.8188 * \ln(C_s) – 4.8471$ | 14.7 |
| Barium | 103 | 1710 | $C_m = 0.00015 * 50 * C_d$ | 0.51 |
| Beryllium | 0.009 | 1.3 | $C_m = 0.001 * 50 * C_d$ | 0.0002 |
| Cadmium | 0.008 | 1.3 | $\ln(C_m) = 0.4723 * \ln(C_s) – 1.2571$ | 0.32 |
| Chromium | 0.57 | 101 | $\ln(C_m) = 0.7338 * \ln(C_s) – 1.4599$ | 6.87 |
| Cobalt | 5.3 | 38.8 | $\ln(C_m) = 1.307 * \ln(C_s) – 4.4669$ | 1.37 |
| Copper | 0.71 | 139 | $\ln(C_m) = 0.1444 * \ln(C_s) + 2.042$ | 15.7 |
| Lead | 0.079 | 3090 | $\ln(C_m) = 0.4422 * \ln(C_s)+0.0761$ | 38 |
| Manganese | 379 | 4230 | $C_m = 0.0205 * C_s$ | 86.7 |
| Mercury | 0.385 | 1620 | $C_m = 0.25 * 50 * C_d$ | 0.43 |
| Methylmercury | 0.00062 | -- | 3 x (blueberry stem/leaf concentration) | 0.006 |
| Nickel | 19.2 | 97 | $\ln(C_m) = 0.4658 * \ln(C_s) – 0.2462$ | 6.6 |
| Selenium | 0.5 | 0.42 | $\ln(C_m) = 0.3764 * \ln(C_s) – 0.4158$ | 0.48 |
| Silver | 0.026 | 0.123 | $C_m = 0.004 * C_s$ | 0.0005 |
| Thallium | 0.01 | 0.071 | $C_m = 0.1124 * C_s$ | 0.008 |
| Vanadium | 0.22 | 51.9 | $C_m = 0.0123 * C_s$ | 0.64 |
| Zinc | 2.1 | 386 | $\ln(C_m) = 0.0706 * \ln(C_s) + 4.3632$ | 120 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | |
| HPAH sum (NDs = 0.5 MDL) | 3.6 | 109 | $C_m = 0$ | 0 |
| LPAH sum (NDs = 0.5 MDL) | 2.9 | 417 | $C_m = 0$ | 0 |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | |
| 4-Bromophenyl Phenyl Ether | 0.21 | 1.9 | $C_m = C_s$ | 1.9 |
| 4-Methylphenol | 0.26 | 4.9 | $C_m = C_s$ | 4.9 |
| Benzoic Acid | 0.30 | 120 | $C_m = C_s$ | 120 |
| Benzyl Alcohol | 1.0 | 12 | $C_m = C_s$ | 12 |
| Bis(2-ethylhexyl)phthalate | 0.95 | 220 | $C_m = C_s$ | 220 |
| Dibenzofuran | 0.24 | 10 | $C_m = C_s$ | 10 |
| Diethylphthalate | 0.29 | 140 | $C_m = C_s$ | 140 |
| Dimethylphthalate | 0.27 | 160 | $C_m = C_s$ | 160 |
| Hexachlorobenzene | 0.32 | 1.3 | $C_m = C_s$ | 1.3 |
| Pentachlorophenol | 1.25 | 38 | $C_m = C_s$ | 38 |
| Phenol | 0.26 | 4.6 | $C_m = C_s$ | 4.6 |

Key:
-- = not analyzed
$C_d$ = chemical concentration in diet (maximum concentration in blueberry stems/leaves)
$C_m$ = chemical concentration in small mammal tissue
$C_s$ = chemical concentration in soil
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
µg/kg = micrograms per kilogram
µg/L = micrograms per liter

Notes:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors and SVOCs detected in surface soil or surface water are listed.

b. Maximum surface water concentration from Table 4-3. HPAHs, benzyl alcohol, diethylphthalate, di-n-butylphthalate, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the MDL. One-half MDL also used when summing undetected LPAHs.

c. Maximum surface soil concentration from Table 4-1.

d. mg/kg for metals and µg/kg for PCBs and SVOCs.

e. EPA (2005a) except for thallium, which is from Sample et al. (1998b). For chemicals with no available model, the chemical concentration in small mammals was set equal to the maximum surface soil chemical concentration.

## Table 4-13 Common Snipe Exposure Point Concentrations, Red Devil Mine Site SLERA

| Analyte[a] | Surface Water EPC (µg/L)[b] | Sediment EPC[c, d] | Benthic Macroinvertebrate EPC | |
|---|---|---|---|---|
| | | | Value[d] | Basis |
| **Metals** | | | | |
| Antimony | 184 | 6,360 | 21.44 | Maximum measured mayfly concentration (Table 4-5). |
| Arsenic | 1,030 | 130,000 | 126.4 | Maximum measured mayfly concentration (Table 4-5). |
| Barium | 103 | 1,990 | 6.61 | Maximum measured mayfly concentration (Table 4-5). |
| Beryllium | 0.009 | 0.09 | 0.013 | One-half method detection limit (Table 4-5). |
| Cadmium | 0.008 | 0.663 | 0.166 | Maximum measured mayfly concentration (Table 4-5). |
| Chromium | 0.57 | 47.4 | 0.441 | Maximum measured mayfly concentration (Table 4-5). |
| Cobalt | 5.3 | 50 | 50 | Not analyzed in benthic invertebrates. See note e. |
| Copper | 0.71 | 87.5 | 12.4 | Maximum measured mayfly concentration (Table 4-5). |
| Lead | 0.079 | 14.8 | 0.154 | Maximum measured mayfly concentration (Table 4-5). |
| Manganese | 379 | 5,410 | 50.8 | Maximum measured mayfly concentration (Table 4-5). |
| Mercury | 0.385 | 119 | 2.38 | Maximum measured mayfly concentration (Table 4-5). |
| Methylmercury | 0.00062 | 0.0144 | 0.131 | Maximum measured mayfly concentration (Table 4-5). |
| Nickel | 19.2 | 240 | 1.41 | Maximum measured mayfly concentration (Table 4-5). |
| Selenium | 0.5 | 2.11 | 4.05 | Maximum measured mayfly concentration (Table 4-5). |
| Silver | 0.026 | 0.41 | 0.41 | Not analyzed in benthic invertebrates. See note e. |
| Thallium | 0.01 | 0.653 | 0.653 | Not analyzed in benthic invertebrates. See note e. |
| Vanadium | 0.22 | 48.5 | 0.47 | Maximum measured mayfly concentration (Table 4-5). |
| Zinc | 2.1 | 132 | 44.9 | Maximum measured mayfly concentration (Table 4-5). |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | |
| HPAH sum (NDs = 0.5 MDL) | 3.6 | 8.5 | 8.5 | Not analyzed in benthic invertebrates. See note e. |
| LPAH sum (NDs = 0.5 MDL) | 2.9 | 7.0 | 7.0 | Not analyzed in benthic invertebrates. See note e. |
| **Semivolatile Organic Compounds (SVOCs)** | | | | |
| Benzyl Alcohol | 1.00 | 3.1 | 3.1 | Not analyzed in benthic invertebrates. See note e. |
| Diethyl Phthalate | 0.29 | 1.7 | 1.7 | Not analyzed in benthic invertebrates. See note e. |
| Di-n-butyl Phthalate | 0.27 | 9 | 9 | Not analyzed in benthic invertebrates. See note e. |
| Pentachlorophenol | 1.25 | 22 | 22 | Not analyzed in benthic invertebrates. See note e. |
| Phenol | 0.26 | 4.1 | 4.1 | Not analyzed in benthic invertebrates. See note e. |

Key:
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weigjht PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening levels ecological risk assessment
SVOC = Semivolatile organic compound.
µg/kg = micrograms per kilogram
µg/L = micrograms per kilogram

Notes:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). SVOCs that were detected in sediment or surface water are listed.
b. Maximum concentration from Table 4-3. HPAHs, benzyl alcohol, diethylphthalate, di-n-butylphthalate, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the method detection limit. One-half method detection limit also used for undetected LPAHs.
c. Maximum concentration from Table 4-2.
d. mg/kg for metals and µg/kg for PAHs and SVOCs.
e. Chemical concentration in benthic macroinvertebrate assumed equal to maximum chemical concentration in sediment.

## Table 4-14 Belted Kingfisher and Mink Exposure Point Concentrations, Red Devil Mine Site SLERA

| Analyte[a] | Surface Water EPC (µg/L)[b] | Sediment EPC[c, d] | Slimy Sculpin EPC | |
|---|---|---|---|---|
| | | | Value[d] | Basis |
| **Metals** | | | | |
| Antimony | 184 | 6,360 | 38.1 | Maximum measured sculpin concentration (Table 4-6). |
| Arsenic | 1,030 | 130,000 | 24.1 | Maximum measured sculpin concentration (Table 4-6). |
| Barium | 103 | 1,990 | 5.4 | Maximum measured sculpin concentration (Table 4-6). |
| Beryllium | 0.009 | 0.09 | 0.0125 | One-half method detection limit (Table 4-6). |
| Cadmium | 0.008 | 0.663 | 0.103 | Maximum measured sculpin concentration (Table 4-6). |
| Chromium | 0.57 | 47.4 | 2.431 | Maximum measured sculpin concentration (Table 4-6). |
| Cobalt | 5.3 | 50 | 50 | Not analyzed in sculpin. See note e. |
| Copper | 0.71 | 87.5 | 2.263 | Maximum measured sculpin concentration (Table 4-6). |
| Lead | 0.079 | 14.8 | 0.079 | Maximum measured sculpin concentration (Table 4-6). |
| Manganese | 379 | 5,410 | 21.3 | Maximum measured sculpin concentration (Table 4-6). |
| Mercury | 0.385 | 119 | 3.7 | Maximum measured sculpin concentration (Table 4-6). |
| Methylmercury | 0.00062 | 0.0144 | 0.312 | Maximum measured sculpin concentration (Table 4-6). |
| Nickel | 19.2 | 240 | 0.263 | Maximum measured sculpin concentration (Table 4-6). |
| Selenium | 0.5 | 2.11 | 2.98 | Maximum measured sculpin concentration (Table 4-6). |
| Silver | 0.026 | 0.41 | 0.41 | Not analyzed in sculpin. See note e. |
| Thallium | 0.01 | 0.653 | 0.635 | Not analyzed in sculpin. See note e. |
| Vanadium | 0.22 | 48.5 | 0.4 | Maximum measured sculpin concentration (Table 4-6). |
| Zinc | 2.1 | 132 | 35.4 | Maximum measured sculpin concentration (Table 4-6). |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | |
| HPAH sum (NDs = 0.5 MDL) | 3.6 | 8.5 | 8.5 | Not analyzed in sculpin. See note e. |
| LPAH sum (NDs = 0.5 MDL) | 2.9 | 7.0 | 7.0 | Not analyzed in sculpin. See note e. |
| **Semivolatile Organic Compounds (SVOCs)** | | | | |
| Benzyl Alcohol | 1.00 | 3.1 | 3.1 | Not analyzed in sculpin. See note e. |
| Diethyl Phthalate | 0.29 | 1.7 | 1.7 | Not analyzed in sculpin. See note e. |
| Di-n-butyl Phthalate | 0.27 | 9 | 9 | Not analyzed in sculpin. See note e. |
| Pentachlorophenol | 1.25 | 22 | 22 | Not analyzed in sculpin. See note e. |
| Phenol | 0.26 | 4.1 | 4.1 | Not analyzed in sculpin. See note e. |

Key:
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening levels ecological risk assessment
SVOC = Semivolatile organic compound.
µg/kg = micrograms per kilogram
µg/L = micrograms per kilogram

Notes:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.
b. Maximum concentrations from Table 4-3. HPAHs, benzyl alcohol, diethylphthalate, di-n-butylphthalate, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the method detection limit. One-half method detection limit also used for undetected LPAHs.
c. Maximum concentrations from Table 4-2.
d. mg/kg for metals and µg/kg for PAHs and SVOCs.
e. Sculpin chemical concentration assumed equal to maximum concentration in sediment.

**Table 4-15 American Robin Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls (PCBs)** | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | 1.9E-07 | -- | 2.5E-06 | 2.7E-06 | 0.18 | 1.5E-05 |
| Metals | | | | | | |
| Antimony | 5.7E+01 | 2.6E-02 | 5.6E+03 | 5.7E+03 | -- | -- |
| Arsenic | 2.4E+01 | 1.5E-01 | 3.9E+01 | 6.3E+01 | 2.24 | 28 |
| Barium | 4.2E+00 | 1.5E-02 | 3.8E+01 | 4.2E+01 | 20.8 | 2.0 |
| Beryllium | 3.2E-03 | 1.3E-06 | 1.4E-02 | 1.7E-02 | -- | -- |
| Cadmium | 3.2E-03 | 1.1E-06 | 2.5E+00 | 2.5E+00 | 1.47 | 1.7 |
| Chromium | 2.5E-01 | 8.1E-05 | 7.5E+00 | 7.7E+00 | 2.66 | 2.9 |
| Cobalt | 9.6E-02 | 7.6E-04 | 1.1E+00 | 1.2E+00 | 7.61 | 0.16 |
| Copper | 3.4E-01 | 1.0E-04 | 1.7E+01 | 1.8E+01 | 4.05 | 4.4 |
| Lead | 7.6E+00 | 1.1E-05 | 1.3E+02 | 1.3E+02 | 1.63 | 83 |
| Manganese | 1.0E+01 | 5.4E-02 | 3.2E+01 | 4.2E+01 | 179 | 0.24 |
| Mercury | 4.0E+00 | 5.5E-05 | 2.9E-01 | 4.3E+00 | 0.45 | 9.5 |
| Methylmercury | -- | 8.9E-08 | 1.4E-03 | 1.4E-03 | 0.068 | 0.02 |
| Nickel | 2.4E-01 | 2.7E-03 | 2.5E+01 | 2.5E+01 | 6.71 | 3.7 |
| Selenium | 1.0E-03 | 7.1E-05 | 1.2E-01 | 1.2E-01 | 0.291 | 0.41 |
| Silver | 3.0E-04 | 3.7E-06 | 6.1E-02 | 6.1E-02 | 2.02 | 0.03 |
| Thallium | 1.8E-04 | 1.4E-06 | 1.7E-02 | 1.7E-02 | -- | -- |
| Vanadium | 1.3E-01 | 3.1E-05 | 5.3E-01 | 6.5E-01 | 0.344 | 1.9 |
| Zinc | 9.5E-01 | 3.0E-04 | 1.5E+02 | 1.5E+02 | 66.1 | 2.2 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 2.7E-04 | 5.1E-04 | 6.8E-02 | 6.9E-02 | 2 | 0.034 |
| LPAH sum (NDs = 0.5 MDL) | 1.0E-03 | 4.1E-04 | 3.0E-01 | 3.0E-01 | -- | -- |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| 4-Bromophenyl phenyl ether | 4.7E-06 | 3.0E-05 | 4.6E-04 | 4.9E-04 | -- | -- |
| 4-Methylphenol | 1.2E-05 | 3.7E-05 | 1.2E-03 | 1.2E-03 | -- | -- |
| Benzoic acid | 3.0E-04 | 4.2E-05 | 2.9E-02 | 2.9E-02 | -- | -- |
| Benzyl alcohol | 3.0E-05 | 1.4E-04 | 2.9E-03 | 3.1E-03 | -- | -- |
| Bis(2-ethylhexyl)phthalate | 5.4E-04 | 1.4E-04 | 5.3E-02 | 5.4E-02 | 1.11 | 0.05 |
| Dibenzofuran | 2.5E-05 | 3.4E-05 | 2.4E-03 | 2.5E-03 | -- | -- |
| Diethylphthalate | 3.5E-04 | 4.1E-05 | 3.4E-02 | 3.4E-02 | -- | -- |
| Dimethylphthalate | 3.9E-04 | 3.8E-05 | 3.9E-02 | 3.9E-02 | -- | -- |
| Hexachlorobenzene | 3.2E-06 | 4.5E-05 | 3.1E-04 | 3.6E-04 | 0.56 | 0.0006 |
| Pentachlorophenol | 9.4E-05 | 1.8E-04 | 9.2E-03 | 9.5E-03 | 6.73 | 0.001 |
| Phenol | 1.1E-05 | 3.7E-05 | 1.1E-03 | 1.2E-03 | 6 | 0.0002 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:

a = Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

**Table 4-16 Masked Shrew Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls** | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | 1.3E-06 | -- | 3.4E-06 | 4.8E-06 | 0.14 | 3.4E-05 |
| **Metals** | | | | | | |
| Antimony | 4.0E+02 | 3.2E-02 | 7.6E+03 | 8.0E+03 | 0.059 | 136370 |
| Arsenic | 1.7E+02 | 1.8E-01 | 5.2E+01 | 2.2E+02 | 1.04 | 214 |
| Barium | 2.9E+01 | 1.8E-02 | 5.1E+01 | 8.0E+01 | 51.8 | 1.6 |
| Beryllium | 2.2E-02 | 1.5E-06 | 1.9E-02 | 4.2E-02 | 0.532 | 0.08 |
| Cadmium | 2.2E-02 | 1.4E-06 | 3.3E+00 | 3.4E+00 | 0.77 | 4.4 |
| Chromium | 1.7E+00 | 9.8E-05 | 1.0E+01 | 1.2E+01 | 9.24 | 1.29 |
| Cobalt | 6.7E-01 | 9.1E-04 | 1.6E+00 | 2.2E+00 | 7.33 | 0.30 |
| Copper | 2.4E+00 | 1.2E-04 | 2.3E+01 | 2.6E+01 | 5.6 | 4.6 |
| Lead | 5.3E+01 | 1.4E-05 | 1.7E+02 | 2.3E+02 | 4.7 | 48 |
| Manganese | 7.3E+01 | 6.5E-02 | 4.3E+01 | 1.2E+02 | 51.5 | 2.3 |
| Mercury | 2.8E+01 | 6.6E-05 | 4.8E-03 | 2.8E+01 | 13.2 | 2.1 |
| Methylmercury | -- | 1.1E-07 | 2.0E-03 | 2.0E-03 | 0.032 | 0.06 |
| Nickel | 1.7E+00 | 3.3E-03 | 3.4E+01 | 3.5E+01 | 1.7 | 21 |
| Selenium | 7.2E-03 | 8.6E-05 | 1.6E-01 | 1.7E-01 | 0.143 | 1.2 |
| Silver | 2.1E-03 | 4.5E-06 | 8.3E-02 | 8.5E-02 | 6.02 | 0.014 |
| Thallium | 1.2E-03 | 1.7E-06 | 2.3E-02 | 2.5E-02 | 0.0074 | 3.3 |
| Vanadium | 8.9E-01 | 3.8E-05 | 7.2E-01 | 1.6E+00 | 4.16 | 0.39 |
| Zinc | 6.6E+00 | 3.6E-04 | 2.0E+02 | 2.0E+02 | 75.4 | 2.7 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 1.9E-03 | 6.1E-04 | 9.3E-02 | 9.5E-02 | 0.615 | 0.15 |
| LPAH sum (NDs = 0.5 MDL) | 7.2E-03 | 4.9E-04 | 4.1E-01 | 4.2E-01 | 65.6 | 0.006 |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| 4-Bromophenyl phenyl ether | 3.3E-05 | 3.6E-05 | 6.2E-04 | 6.9E-04 | -- | -- |
| 4-Methylphenol | 8.4E-05 | 4.5E-05 | 1.6E-03 | 1.7E-03 | 219 | 7.9E-06 |
| Benzoic acid | 2.1E-03 | 5.1E-05 | 3.9E-02 | 4.1E-02 | -- | -- |
| Benzyl alcohol | 2.1E-04 | 1.7E-04 | 3.9E-03 | 4.3E-03 | -- | -- |
| Bis(2-Ethylhexyl)phthalate | 3.8E-03 | 1.6E-04 | 7.2E-02 | 7.6E-02 | 18.33 | 0.004 |
| Dibenzofuran | 1.7E-04 | 4.1E-05 | 3.3E-03 | 3.5E-03 | -- | -- |
| Diethylphthalate | 2.4E-03 | 5.0E-05 | 4.6E-02 | 4.8E-02 | 4583 | 1.1E-05 |
| Dimethylphthalate | 2.8E-03 | 4.6E-05 | 5.3E-02 | 5.5E-02 | -- | -- |
| Hexachlorobenzene | 2.2E-05 | 5.4E-05 | 4.3E-04 | 5.0E-04 | 0.014 | 0.036 |
| Pentachlorophenol | 6.5E-04 | 2.1E-04 | 1.2E-02 | 1.3E-02 | 8.42 | 0.002 |
| Phenol | 7.9E-05 | 4.5E-05 | 1.5E-03 | 1.6E-03 | 523 | 3.1E-06 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

**Table 4-17 Spruce Grouse Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls (PCBs)** | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | 8.2E-07 | -- | 8.8E-06 | 9.7E-06 | 0.18 | 5.4E-05 |
| **Metals** | | | | | | |
| Antimony | 2.5E+02 | 1.3E-02 | 1.7E+00 | 2.5E+02 | -- | -- |
| Arsenic | 1.0E+02 | 7.4E-02 | 1.3E+00 | 1.1E+02 | 2.24 | 47 |
| Barium | 1.8E+01 | 7.4E-03 | 9.7E+00 | 2.8E+01 | 20.8 | 1.3 |
| Beryllium | 1.4E-02 | 6.5E-07 | 9.1E-04 | 1.5E-02 | -- | -- |
| Cadmium | 1.4E-02 | 5.7E-07 | 2.2E-02 | 3.5E-02 | 1.47 | 0.0 |
| Chromium | 1.1E+00 | 4.1E-05 | 1.5E-01 | 1.2E+00 | 2.66 | 0.46 |
| Cobalt | 4.1E-01 | 3.8E-04 | 3.4E-02 | 4.4E-01 | 7.61 | 0.058 |
| Copper | 1.5E+00 | 5.1E-05 | 5.0E-01 | 2.0E+00 | 4.05 | 0.49 |
| Lead | 3.3E+01 | 5.7E-06 | 5.3E-02 | 3.3E+01 | 1.63 | 20 |
| Manganese | 4.5E+01 | 2.7E-02 | 3.4E+02 | 3.8E+02 | 179 | 2.1 |
| Mercury | 1.7E+01 | 2.8E-05 | 6.4E-01 | 1.8E+01 | 0.45 | 39 |
| Methylmercury | -- | 4.4E-08 | 2.3E-04 | 2.3E-04 | 0.068 | 0.003 |
| Nickel | 1.0E+00 | 1.4E-03 | 7.2E-01 | 1.7E+00 | 6.71 | 0.26 |
| Selenium | 4.4E-03 | 3.6E-05 | 8.5E-03 | 1.3E-02 | 0.291 | 0.04 |
| Silver | 1.3E-03 | 1.9E-06 | 1.3E-02 | 1.4E-02 | 2.02 | 0.007 |
| Thallium | 7.5E-04 | 7.2E-07 | 2.4E-03 | 3.1E-03 | NA | NA |
| Vanadium | 5.5E-01 | 1.6E-05 | 5.3E-02 | 6.0E-01 | 0.344 | 1.7 |
| Zinc | 4.1E+00 | 1.5E-04 | 6.0E+00 | 1.0E+01 | 66.1 | 0.15 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 0.001 | 2.6E-04 | 1.2E-02 | 1.4E-02 | 2 | 0.007 |
| LPAH sum (NDs = 0.5 MDL) | 0.004 | 2.1E-04 | 4.7E-02 | 5.2E-02 | -- | -- |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| 4-Bromophenyl phenyl ether | 2.0E-05 | 1.5E-05 | 2.2E-04 | 2.5E-04 | -- | -- |
| 4-Methylphenol | 5.2E-05 | 1.9E-05 | 5.5E-04 | 6.3E-04 | -- | -- |
| Benzoic acid | 1.3E-03 | 2.1E-05 | 1.4E-02 | 1.5E-02 | -- | -- |
| Benzyl alcohol | 1.3E-04 | 7.2E-05 | 1.4E-03 | 1.6E-03 | -- | -- |
| Bis(2-Ethylhexyl)phthalate | 2.3E-03 | 6.8E-05 | 2.5E-02 | 2.7E-02 | 1.11 | 0.02 |
| Dibenzofuran | 1.1E-04 | 1.7E-05 | 1.1E-03 | 1.3E-03 | -- | -- |
| Diethylphthalate | 1.5E-03 | 2.1E-05 | 1.6E-02 | 1.7E-02 | -- | -- |
| Dimethylphthalate | 1.7E-03 | 1.9E-05 | 1.8E-02 | 2.0E-02 | -- | -- |
| Hexachlorobenzene | 1.4E-05 | 2.3E-05 | 1.5E-04 | 1.8E-04 | 0.56 | 0.0003 |
| Pentachlorophenol | 4.0E-04 | 9.0E-05 | 4.3E-03 | 4.8E-03 | 6.73 | 0.001 |
| Phenol | 4.9E-05 | 1.9E-05 | 5.2E-04 | 5.9E-04 | 6 | 0.0001 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg/day = milligrams per kilogram per day
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

**Table 4-18 Tundra Vole Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls (PCBs)** | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | 3.3E-07 | -- | 1.4E-05 | 1.4E-05 | 0.14 | 1.0E-04 |
| **Metals** | | | | | | |
| Antimony | 9.9E+01 | 2.5E-02 | 2.4E-02 | 9.9E+01 | 0.059 | 1681 |
| Arsenic | 4.2E+01 | 1.4E-01 | 2.7E-02 | 4.2E+01 | 1.04 | 41 |
| Barium | 7.3E+00 | 1.4E-02 | 1.2E+01 | 2.0E+01 | 51.8 | 0.38 |
| Beryllium | 5.5E-03 | 1.2E-06 | 5.4E-04 | 6.1E-03 | 0.532 | 0.01 |
| Cadmium | 5.5E-03 | 1.1E-06 | 2.2E-01 | 2.2E-01 | 0.77 | 0.29 |
| Chromium | 4.3E-01 | 7.6E-05 | 3.6E-02 | 4.7E-01 | 9.24 | 0.05 |
| Cobalt | 1.7E-01 | 7.1E-04 | 1.8E-02 | 1.8E-01 | 7.33 | 0.025 |
| Copper | 5.9E-01 | 9.5E-05 | 1.1E+00 | 1.7E+00 | 5.6 | 0.3 |
| Lead | 1.3E+01 | 1.1E-05 | 1.2E-02 | 1.3E+01 | 4.7 | 2.8 |
| Manganese | 1.8E+01 | 5.1E-02 | 2.9E+02 | 3.1E+02 | 51.5 | 6.1 |
| Mercury | 6.9E+00 | 5.2E-05 | 6.1E-03 | 6.9E+00 | 13.2 | 0.52 |
| Methylmercury | -- | 8.3E-08 | 3.6E-04 | 3.6E-04 | 0.032 | 0.011 |
| Nickel | 4.1E-01 | 2.6E-03 | 1.2E+00 | 1.6E+00 | 1.7 | 0.95 |
| Selenium | 1.8E-03 | 6.7E-05 | 1.4E-02 | 1.5E-02 | 0.143 | 0.11 |
| Silver | 5.2E-04 | 3.5E-06 | 7.2E-04 | 1.3E-03 | 6.02 | 0.00 |
| Thallium | 3.0E-04 | 1.3E-06 | 1.1E-03 | 1.4E-03 | 0.0074 | 0.19 |
| Vanadium | 2.2E-01 | 2.9E-05 | 5.4E-03 | 2.3E-01 | 4.16 | 0.05 |
| Zinc | 1.6E+00 | 2.8E-04 | 7.7E+00 | 9.3E+00 | 75.4 | 0.12 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 4.6E-04 | 4.8E-04 | 2.0E-02 | 2.1E-02 | 0.615 | 0.03 |
| LPAH sum (NDs = 0.5 MDL) | 1.8E-03 | 3.8E-04 | 7.5E-02 | 7.8E-02 | 65.6 | 0.001 |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| 4-Bromophenyl phenyl ether | 8.1E-06 | 2.8E-05 | 3.4E-04 | 3.8E-04 | -- | -- |
| 4-Methylphenol | 2.1E-05 | 3.5E-05 | 8.9E-04 | 9.4E-04 | 219 | 4.3E-06 |
| Benzoic acid | 5.1E-04 | 4.0E-05 | 2.2E-02 | 2.2E-02 | -- | -- |
| Benzyl alcohol | 5.1E-05 | 1.3E-04 | 2.2E-03 | 2.4E-03 | -- | -- |
| Bis(2-Ethylhexyl)phthalate | 9.4E-04 | 1.3E-04 | 4.0E-02 | 4.1E-02 | 18.33 | 0.002 |
| Dibenzofuran | 4.3E-05 | 3.2E-05 | 1.8E-03 | 1.9E-03 | -- | -- |
| Diethylphthalate | 6.0E-04 | 3.9E-05 | 2.5E-02 | 2.6E-02 | 4583 | 5.7E-06 |
| Dimethylphthalate | 6.8E-04 | 3.6E-05 | 2.9E-02 | 3.0E-02 | -- | -- |
| Hexachlorobenzene | 5.5E-06 | 4.2E-05 | 2.4E-04 | 2.8E-04 | 0.014 | 0.020 |
| Pentachlorophenol | 1.6E-04 | 1.7E-04 | 6.9E-03 | 7.2E-03 | 8.42 | 0.001 |
| Phenol | 2.0E-05 | 3.5E-05 | 8.3E-04 | 8.9E-04 | 523 | 1.7E-06 |

Key:

-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

**Table 4-19 Northern Shrike Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls (PCBs)** | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | 0.0E+00 | -- | 1.7E-05 | 1.7E-05 | 0.18 | 9.2E-05 |
| **Metals** | | | | | | |
| Antimony | 0.0E+00 | 2.7E-02 | 1.4E-03 | 2.8E-02 | -- | -- |
| Arsenic | 0.0E+00 | 1.5E-01 | 3.1E+00 | 3.3E+00 | 2.24 | 1.45 |
| Barium | 0.0E+00 | 1.5E-02 | 1.1E-01 | 1.2E-01 | 20.8 | 0.01 |
| Beryllium | 0.0E+00 | 1.3E-06 | 3.2E-05 | 3.3E-05 | -- | -- |
| Cadmium | 0.0E+00 | 1.2E-06 | 6.8E-02 | 6.8E-02 | 1.47 | 0.05 |
| Chromium | 0.0E+00 | 8.3E-05 | 1.5E+00 | 1.5E+00 | 2.66 | 0.5 |
| Cobalt | 0.0E+00 | 7.7E-04 | 2.9E-01 | 2.9E-01 | 7.61 | 0.038 |
| Copper | 0.0E+00 | 1.0E-04 | 3.3E+00 | 3.3E+00 | 4.05 | 0.8 |
| Lead | 0.0E+00 | 1.1E-05 | 8.0E+00 | 8.0E+00 | 1.63 | 4.9 |
| Manganese | 0.0E+00 | 5.5E-02 | 1.8E+01 | 1.8E+01 | 179 | 0.10 |
| Mercury | 0.0E+00 | 5.6E-05 | 9.0E-02 | 9.0E-02 | 0.45 | 0.20 |
| Methylmercury | -- | 9.0E-08 | 1.3E-03 | 1.3E-03 | 0.068 | 0.02 |
| Nickel | 0.0E+00 | 2.8E-03 | 1.4E+00 | 1.4E+00 | 6.71 | 0.21 |
| Selenium | 0.0E+00 | 7.2E-05 | 1.0E-01 | 1.0E-01 | 0.291 | 0.35 |
| Silver | 0.0E+00 | 3.8E-06 | 1.0E-04 | 1.1E-04 | 2.02 | 0.0001 |
| Thallium | 0.0E+00 | 1.4E-06 | 1.7E-03 | 1.7E-03 | -- | -- |
| Vanadium | 0.0E+00 | 3.2E-05 | 1.4E-01 | 1.4E-01 | 0.344 | 0.39 |
| Zinc | 0.0E+00 | 3.0E-04 | 2.5E+01 | 2.5E+01 | 66.1 | 0.38 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 0.0E+00 | 5.2E-04 | 0.0E+00 | 5.2E-04 | 2 | 0.0003 |
| LPAH sum (NDs = 0.5 MDL) | 0.0E+00 | 4.2E-04 | 0.0E+00 | 4.2E-04 | -- | -- |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| 4-Bromophenyl phenyl ether | 0.0E+00 | 3.0E-05 | 4.0E-04 | 4.3E-04 | -- | -- |
| 4-Methylphenol | 0.0E+00 | 3.8E-05 | 1.0E-03 | 1.1E-03 | -- | -- |
| Benzoic acid | 0.0E+00 | 4.3E-05 | 2.5E-02 | 2.5E-02 | -- | -- |
| Benzyl alcohol | 0.0E+00 | 1.4E-04 | 2.5E-03 | 2.7E-03 | -- | -- |
| Bis(2-Ethylhexyl)phthalate | 0.0E+00 | 1.4E-04 | 4.7E-02 | 4.7E-02 | 1.11 | 0.04 |
| Dibenzofuran | 0.0E+00 | 3.5E-05 | 2.1E-03 | 2.2E-03 | -- | -- |
| Diethylphthalate | 0.0E+00 | 4.2E-05 | 3.0E-02 | 3.0E-02 | -- | -- |
| Dimethylphthalate | 0.0E+00 | 3.8E-05 | 3.4E-02 | 3.4E-02 | -- | -- |
| Hexachlorobenzene | 0.0E+00 | 4.6E-05 | 2.8E-04 | 3.2E-04 | 0.56 | 0.0006 |
| Pentachlorophenol | 0.0E+00 | 1.8E-04 | 8.1E-03 | 8.2E-03 | 6.73 | 0.001 |
| Phenol | 0.0E+00 | 3.8E-05 | 9.7E-04 | 1.0E-03 | 6 | 0.0002 |

Key:
-- = not available.
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NOAEL = no observed adverse effect level
mg/kg = Milligrams per kilogram
mg/kg/day = Milligrams per kilogram per day
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:

a = Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

**Table 4-20 Least Weasel Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-soil (mg/kg/d) | EE water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls** | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | 0.0E+00 | -- | 9.6E-06 | 9.6E-06 | 0.14 | 6.9E-05 |
| **Metals** | | | | | | |
| Antimony | 0.0E+00 | 2.5E-02 | 8.1E-04 | 2.6E-02 | 0.059 | 0.44 |
| Arsenic | 0.0E+00 | 1.4E-01 | 1.8E+00 | 1.9E+00 | 1.04 | 1.9 |
| Barium | 0.0E+00 | 1.4E-02 | 6.3E-02 | 7.7E-02 | 51.8 | 0.0015 |
| Beryllium | 0.0E+00 | 1.2E-06 | 1.8E-05 | 2.0E-05 | 0.532 | 3.7E-05 |
| Cadmium | 0.0E+00 | 1.1E-06 | 4.0E-02 | 4.0E-02 | 0.77 | 0.051 |
| Chromium | 0.0E+00 | 7.7E-05 | 8.5E-01 | 8.5E-01 | 9.24 | 0.091 |
| Cobalt | 0.0E+00 | 7.2E-04 | 1.7E-01 | 1.7E-01 | 7.33 | 0.023 |
| Copper | 0.0E+00 | 9.6E-05 | 1.9E+00 | 1.9E+00 | 5.6 | 0.3 |
| Lead | 0.0E+00 | 1.1E-05 | 4.6E+00 | 4.6E+00 | 4.7 | 1.0 |
| Manganese | 0.0E+00 | 5.2E-02 | 1.1E+01 | 1.1E+01 | 51.5 | 0.21 |
| Mercury | 0.0E+00 | 5.2E-05 | 5.2E-02 | 5.2E-02 | 13.2 | 0.004 |
| Methylmercury | -- | 8.4E-08 | 7.4E-04 | 7.4E-04 | 0.032 | 0.02 |
| Nickel | 0.0E+00 | 2.6E-03 | 8.1E-01 | 8.1E-01 | 1.7 | 0.5 |
| Selenium | 0.0E+00 | 6.8E-05 | 5.9E-02 | 5.9E-02 | 0.143 | 0.41 |
| Silver | 0.0E+00 | 3.5E-06 | 6.1E-05 | 6.4E-05 | 6.02 | 1.1E-05 |
| Thallium | 0.0E+00 | 1.4E-06 | 9.8E-04 | 9.8E-04 | 0.0074 | 0.13 |
| Vanadium | 0.0E+00 | 3.0E-05 | 7.9E-02 | 7.9E-02 | 4.16 | 0.02 |
| Zinc | 0.0E+00 | 2.9E-04 | 1.5E+01 | 1.5E+01 | 75.4 | 0.20 |
| **Polycyclic Aromatic Hydrocarbons** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 0.0E+00 | 4.9E-04 | 0.0E+00 | 4.9E-04 | 0.615 | 0.0008 |
| LPAH sum (NDs = 0.5 MDL) | 0.0E+00 | 3.9E-04 | 0.0E+00 | 3.9E-04 | 65.6 | 5.9E-06 |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| 4-Bromophenyl phenyl ether | 0.0E+00 | 2.9E-05 | 2.3E-04 | 2.6E-04 | -- | -- |
| 4-Methylphenol | 0.0E+00 | 3.5E-05 | 6.0E-04 | 6.4E-04 | 219 | 2.9E-06 |
| Benzoic acid | 0.0E+00 | 4.0E-05 | 1.5E-02 | 1.5E-02 | -- | -- |
| Benzyl alcohol | 0.0E+00 | 1.4E-04 | 1.5E-03 | 1.6E-03 | -- | -- |
| Bis(2-Ethylhexyl)phthalate | 0.0E+00 | 1.3E-04 | 2.7E-02 | 2.7E-02 | 18.33 | 0.001 |
| Dibenzofuran | 0.0E+00 | 3.3E-05 | 1.2E-03 | 1.3E-03 | -- | -- |
| Diethylphthalate | 0.0E+00 | 3.9E-05 | 1.7E-02 | 1.7E-02 | 4583 | 3.8E-06 |
| Dimethylphthalate | 0.0E+00 | 3.6E-05 | 2.0E-02 | 2.0E-02 | -- | -- |
| Hexachlorobenzene | 0.0E+00 | 4.3E-05 | 1.6E-04 | 2.0E-04 | 0.014 | 0.014 |
| Pentachlorophenol | 0.0E+00 | 1.7E-04 | 4.7E-03 | 4.8E-03 | 8.42 | 0.001 |
| Phenol | 0.0E+00 | 3.5E-05 | 5.7E-04 | 6.0E-04 | 523 | 1.2E-06 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = not detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors and SVOCs detected in surface soil or surface water are listed.

**Table 4-21 Common Snipe Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Antimony | 8.8E+01 | 2.2E-02 | 8.7E+00 | 9.6E+01 | -- | -- |
| Arsenic | 1.8E+03 | 1.2E-01 | 5.1E+01 | 1.8E+03 | 2.24 | 823 |
| Barium | 2.7E+01 | 1.2E-02 | 2.7E+00 | 3.0E+01 | 20.8 | 1.4 |
| Beryllium | 1.2E-03 | 1.1E-06 | 5.1E-03 | 6.3E-03 | -- | -- |
| Cadmium | 9.1E-03 | 9.7E-07 | 6.7E-02 | 7.6E-02 | 1.47 | 0.05 |
| Chromium | 6.5E-01 | 6.9E-05 | 1.8E-01 | 8.3E-01 | 2.66 | 0.31 |
| Cobalt | 6.9E-01 | 6.4E-04 | 6.5E+00 | 7.2E+00 | 7.61 | 0.94 |
| Copper | 1.2E+00 | 8.6E-05 | 5.0E+00 | 6.2E+00 | 4.05 | 1.5 |
| Lead | 2.0E-01 | 9.5E-06 | 6.2E-02 | 2.7E-01 | 1.63 | 0.16 |
| Manganese | 7.5E+01 | 4.6E-02 | 2.1E+01 | 9.5E+01 | 179 | 0.5 |
| Mercury | 1.6E+00 | 4.6E-05 | 9.6E-01 | 2.6E+00 | 0.45 | 5.8 |
| Methylmercury | 2.0E-04 | 7.5E-08 | 5.3E-02 | 5.3E-02 | 0.068 | 0.78 |
| Nickel | 3.3E+00 | 2.3E-03 | 5.7E-01 | 3.9E+00 | 6.71 | 0.58 |
| Selenium | 2.9E-02 | 6.0E-05 | 1.6E+00 | 1.7E+00 | 0.291 | 5.72 |
| Silver | 5.7E-03 | 3.1E-06 | 5.3E-02 | 5.9E-02 | 2.02 | 0.03 |
| Thallium | 9.0E-03 | 1.2E-06 | 8.4E-02 | 9.3E-02 | -- | -- |
| Vanadium | 6.7E-01 | 2.7E-05 | 1.9E-01 | 8.6E-01 | 0.344 | 2.50 |
| Zinc | 1.8E+00 | 2.5E-04 | 1.8E+01 | 2.0E+01 | 66.1 | 0.30 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 1.2E-04 | 4.3E-04 | 1.1E-03 | 1.6E-03 | 2 | 0.0008 |
| LPAH sum (NDs = 0.5 MDL) | 9.7E-05 | 3.5E-04 | 9.1E-04 | 1.3E-03 | -- | -- |
| **Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| Benzyl Alcohol | 4.3E-05 | 1.2E-04 | 4.0E-04 | 5.6E-04 | -- | -- |
| Diethyl Phthalate | 2.3E-05 | 3.5E-05 | 2.2E-04 | 2.8E-04 | -- | -- |
| Di-n-butyl Phthalate | 1.2E-04 | 3.3E-05 | 1.2E-03 | 1.3E-03 | 0.11 | 0.0120 |
| Pentachlorophenol | 3.0E-04 | 1.5E-04 | 2.8E-03 | 3.3E-03 | 6.73 | 0.0005 |
| Phenol | 5.7E-05 | 3.1E-05 | 5.3E-04 | 6.2E-04 | 6 | 0.0001 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NA = Not available
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.

## Table 4-22 Beaver Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

| Analyte[a] | Surface Soil EPC[b] | Surface Water EPC (µg/L) | EE-soil (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|---|---|
| **Polychlorinated Biphenyls (PCBs)** | | | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | 0.078 | -- | 1.2E-08 | -- | 5.9E-07 | 6.0E-07 | 0.14 | 4.3E-06 |
| **Metals** | | | | | | | | |
| Antimony | 23300 | 184 | 3.5E+00 | 1.3E-02 | 2.5E-02 | 3.6E+00 | 0.059 | 60 |
| Arsenic | 9880 | 1,030 | 1.5E+00 | 7.4E-02 | 6.9E-03 | 1.6E+00 | 1.04 | 1.5 |
| Barium | 1710 | 103 | 2.6E-01 | 7.4E-03 | 1.5E+00 | 1.8E+00 | 51.8 | 0.03 |
| Beryllium | 1.3 | 0.009 | 2.0E-04 | 6.5E-07 | 1.1E-04 | 3.1E-04 | 0.532 | 0.001 |
| Cadmium | 1.3 | 0.008 | 2.0E-04 | 5.7E-07 | 9.8E-04 | 1.2E-03 | 0.77 | 0.002 |
| Chromium | 101 | 0.57 | 1.5E-02 | 4.1E-05 | 1.1E-02 | 2.6E-02 | 9.24 | 0.003 |
| Cobalt | 38.8 | 5.3 | 5.9E-03 | 3.8E-04 | 4.0E-03 | 1.0E-02 | 7.33 | 0.001 |
| Copper | 139 | 0.71 | 2.1E-02 | 5.1E-05 | 5.0E-02 | 7.1E-02 | 5.6 | 0.013 |
| Lead | 3090 | 0.079 | 4.7E-01 | 5.7E-06 | 8.6E-04 | 4.7E-01 | 4.7 | 0.099 |
| Manganese | 4230 | 379 | 6.4E-01 | 2.7E-02 | 8.7E+00 | 9.3E+00 | 51.5 | 0.18 |
| Mercury | 1620 | 0.385 | 2.4E-01 | 2.8E-05 | 2.2E-03 | 2.5E-01 | 13.2 | 0.019 |
| Methylmercury | -- | 0.00062 | -- | 4.5E-08 | 1.5E-05 | 1.5E-05 | 0.032 | 0.0005 |
| Nickel | 97 | 19.2 | 1.5E-02 | 1.4E-03 | 3.2E-02 | 4.8E-02 | 1.7 | 0.028 |
| Selenium | 0.42 | 0.5 | 6.3E-05 | 3.6E-05 | 1.7E-03 | 1.8E-03 | 0.143 | 0.012 |
| Silver | 0.123 | 0.026 | 1.9E-05 | 1.9E-06 | 1.5E-03 | 1.5E-03 | 6.02 | 0.0002 |
| Thallium | 0.071 | 0.01 | 1.1E-05 | 7.2E-07 | 2.3E-04 | 2.4E-04 | 0.0074 | 0.032 |
| Vanadium | 51.9 | 0.22 | 7.8E-03 | 1.6E-05 | 5.3E-04 | 8.4E-03 | 4.16 | 0.002 |
| Zinc | 386 | 2.1 | 5.8E-02 | 1.5E-04 | 8.2E-01 | 8.8E-01 | 75.4 | 0.012 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 109 | 3.6 | 1.6E-02 | 2.6E-04 | 8.2E-04 | 1.7E-02 | 0.615 | 0.028 |
| LPAH sum (NDs = 0.5 MDL) | 417 | 2.9 | 6.3E-02 | 2.1E-04 | 3.2E-03 | 6.6E-02 | 65.6 | 0.0010 |
| **Semivolatile Organic Compounds (SVOCs)** | | | | | | | | |
| 4-Bromophenyl phenyl ether | 1.9 | 0.21 | 2.9E-07 | 1.5E-05 | 1.4E-05 | 3.0E-05 | -- | -- |
| 4-Methylphenol | 4.9 | 0.26 | 7.4E-07 | 1.9E-05 | 3.7E-05 | 5.7E-05 | 219 | 2.6E-07 |
| Benzoic acid | 120 | 0.30 | 1.8E-05 | 2.1E-05 | 9.1E-04 | 9.5E-04 | -- | -- |
| Benzyl alcohol | 12 | 1.0 | 1.8E-06 | 7.2E-05 | 9.1E-05 | 1.6E-04 | -- | -- |
| Bis(2-Ethylhexyl)phthalate | 220 | 0.95 | 3.3E-05 | 6.8E-05 | 1.7E-03 | 1.8E-03 | 18.33 | 0.0001 |
| Dibenzofuran | 10 | 0.24 | 1.5E-06 | 1.7E-05 | 7.6E-05 | 9.5E-05 | -- | -- |
| Diethylphthalate | 140 | 0.29 | 2.1E-05 | 2.1E-05 | 1.1E-03 | 1.1E-03 | 4583 | 2.4E-07 |
| Dimethylphthalate | 160 | 0.27 | 2.4E-05 | 1.9E-05 | 1.2E-03 | 1.3E-03 | -- | -- |
| Hexachlorobenzene | 1.3 | 0.32 | 2.0E-07 | 2.3E-05 | 9.9E-06 | 3.3E-05 | 0.014 | 0.002 |
| Pentachlorophenol | 38 | 1.25 | 5.7E-06 | 9.0E-05 | 2.9E-04 | 3.8E-04 | 8.42 | 0.000 |
| Phenol | 4.6 | 0.26 | 6.9E-07 | 1.9E-05 | 3.5E-05 | 5.4E-05 | 523 | 1.0E-07 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

**Table 4-23 Green Winged Teal Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Antimony | 4.5E+00 | 1.6E-02 | 1.6E+01 | 2.1E+01 | -- | -- |
| Arsenic | 3.1E+01 | 8.7E-02 | 5.1E+01 | 8.2E+01 | 2.24 | 37 |
| Barium | 4.5E-01 | 8.7E-03 | 6.0E+00 | 6.5E+00 | 20.8 | 0.31 |
| Beryllium | 2.5E-03 | 7.6E-07 | 9.9E-04 | 3.5E-03 | -- | -- |
| Cadmium | 1.9E-04 | 6.8E-07 | 3.6E-02 | 3.7E-02 | 1.47 | 0.02 |
| Chromium | 5.9E-02 | 4.8E-05 | 9.9E-02 | 1.6E-01 | 2.66 | 0.06 |
| Cobalt | 5.7E-02 | 4.5E-04 | 1.5E-01 | 2.0E-01 | 7.61 | 0.03 |
| Copper | 2.3E-01 | 6.0E-05 | 1.6E+00 | 1.8E+00 | 4.05 | 0.4 |
| Lead | 6.2E-01 | 6.7E-06 | 2.0E-01 | 8.1E-01 | 1.63 | 0.50 |
| Manganese | 3.4E+00 | 3.2E-02 | 3.3E+01 | 3.6E+01 | 179 | 0.2 |
| Mercury | 4.0E-01 | 3.2E-05 | 8.7E-01 | 1.3E+00 | 0.45 | 2.8 |
| Methylmercury | 0.0E+00 | 5.2E-08 | 1.1E-03 | 1.1E-03 | 0.068 | 0.02 |
| Nickel | 1.8E-01 | 1.6E-03 | 5.3E-01 | 7.1E-01 | 6.71 | 0.11 |
| Selenium | 5.5E-03 | 4.2E-05 | 1.3E-01 | 1.4E-01 | 0.291 | 0.48 |
| Silver | 3.8E-04 | 2.2E-06 | 6.6E-04 | 1.0E-03 | 2.02 | 0.001 |
| Thallium | 2.3E-03 | 8.4E-07 | 1.4E-02 | 1.6E-02 | -- | -- |
| Vanadium | 7.9E-02 | 1.9E-05 | 4.8E-02 | 1.3E-01 | 0.344 | 0.37 |
| Zinc | 3.5E-01 | 1.8E-04 | 9.2E+00 | 9.6E+00 | 66.1 | 0.14 |
| **Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| Bis(2-ethylhexyl)phthalate | 6.9E-04 | 4.2E-05 | 3.6E-02 | 3.7E-02 | 1.1 | 0.03 |

Key:
-- = Not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated exposure from incidental sediment (i.e., dry surface soil) ingestion
EE-total = total chemical exposure
HQ = hazard quotient
NOAEL = no observed adverse effect level
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). SVOCs detected in settling pond surface soil (i.e., dry sediment) are listed.

**Table 4-24 Belted Kingfisher Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Antimony | 0.00 | 0.02 | 19.31 | 19.33 | -- | -- |
| Arsenic | 0.00 | 0.11 | 12.21 | 12.32 | 2.24 | 5.5 |
| Barium | 0.00 | 0.01 | 2.74 | 2.75 | 20.8 | 0.13 |
| Beryllium | 0.00 | 9.7E-07 | 0.01 | 0.01 | -- | -- |
| Cadmium | 0.00 | 8.6E-07 | 0.05 | 0.05 | 1.47 | 0.04 |
| Chromium | 0.00 | 6.2E-05 | 1.23 | 1.23 | 2.66 | 0.46 |
| Cobalt | 0.00 | 5.7E-04 | 8.11 | 8.11 | 7.61 | 1.07 |
| Copper | 0.00 | 7.7E-05 | 1.15 | 1.15 | 4.05 | 0.3 |
| Lead | 0.00 | 8.5E-06 | 0.04 | 0.04 | 1.63 | 0.02 |
| Manganese | 0.00 | 0.041 | 10.79 | 10.83 | 179 | 0.1 |
| Mercury | 0.00 | 4.2E-05 | 1.88 | 1.88 | 0.45 | 4.2 |
| Methylmercury | 0.00 | 6.7E-08 | 0.16 | 0.16 | 0.068 | 2.3 |
| Nickel | 0.00 | 2.1E-03 | 0.13 | 0.14 | 6.71 | 0.02 |
| Selenium | 0.00 | 5.4E-05 | 1.51 | 1.51 | 0.291 | 5.2 |
| Silver | 0.00 | 2.8E-06 | 0.07 | 0.07 | 2.02 | 0.03 |
| Thallium | 0.00 | 1.1E-06 | 0.10 | 0.10 | -- | -- |
| Vanadium | 0.00 | 2.4E-05 | 0.20 | 0.20 | 0.344 | 0.59 |
| Zinc | 0.00 | 2.3E-04 | 17.94 | 17.94 | 66.1 | 0.27 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 0.00 | 3.9E-04 | 1.4E-03 | 1.8E-03 | 2 | 0.0009 |
| LPAH sum (NDs = 0.5 MDL) | 0.00 | 3.1E-04 | 1.1E-03 | 1.4E-03 | -- | -- |
| **Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| Benzyl Alcohol | 0.00 | 1.1E-04 | 5.0E-04 | 5.0E-04 | -- | -- |
| Diethyl Phthalate | 0.00 | 3.1E-05 | 2.8E-04 | 2.8E-04 | -- | -- |
| Di-n-butyl Phthalate | 0.00 | 2.9E-05 | 1.5E-03 | 1.5E-03 | 0.11 | 1.3E-02 |
| Pentachlorophenol | 0.00 | 1.4E-04 | 3.6E-03 | 3.6E-03 | 6.73 | 5.3E-04 |
| Phenol | 0.00 | 2.8E-05 | 6.6E-04 | 6.6E-04 | 6 | 1.1E-04 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.

**Table 4-25 Mink Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA**

| Analyte[a] | EE-sediment (mg/kg/d) | EE-water (mg/kg/d) | EE-diet (mg/kg/d) | EE-total (mg/kg/d) | NOAEL (mg/kg/d) | HQ-NOAEL |
|---|---|---|---|---|---|---|
| **Metals** | | | | | | |
| Antimony | 0.00 | 1.8E-02 | 5.22 | 5.24 | 0.059 | 89 |
| Arsenic | 0.00 | 1.0E-01 | 3.30 | 3.40 | 1.04 | 3.3 |
| Barium | 0.00 | 1.0E-02 | 0.74 | 0.75 | 51.8 | 0.014 |
| Beryllium | 0.00 | 8.9E-07 | 0.002 | 0.002 | 0.532 | 0.003 |
| Cadmium | 0.00 | 7.9E-07 | 0.014 | 0.014 | 0.77 | 0.018 |
| Chromium | 0.00 | 5.6E-05 | 0.33 | 0.33 | 9.24 | 0.036 |
| Cobalt | 0.00 | 5.2E-04 | 2.19 | 2.19 | 7.33 | 0.30 |
| Copper | 0.00 | 7.0E-05 | 0.31 | 0.31 | 5.6 | 0.055 |
| Lead | 0.00 | 7.8E-06 | 0.011 | 0.011 | 4.7 | 0.002 |
| Manganese | 0.00 | 3.8E-02 | 2.92 | 2.96 | 51.5 | 0.057 |
| Mercury | 0.00 | 3.8E-05 | 0.51 | 0.51 | 13.2 | 0.038 |
| Methylmercury | 0.00 | 6.1E-08 | 0.043 | 0.043 | 0.032 | 1.3 |
| Nickel | 0.00 | 1.9E-03 | 0.036 | 0.038 | 1.7 | 0.02 |
| Selenium | 0.00 | 5.0E-05 | 0.41 | 0.41 | 0.143 | 2.9 |
| Silver | 0.00 | 2.6E-06 | 0.018 | 0.018 | 6.02 | 0.00 |
| Thallium | 0.00 | 9.9E-07 | 0.028 | 0.028 | 0.0074 | 3.8 |
| Vanadium | 0.00 | 2.2E-05 | 0.05 | 0.055 | 4.16 | 0.013 |
| Zinc | 0.00 | 2.1E-04 | 4.85 | 4.85 | 75.4 | 0.064 |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | |
| HPAH sum (NDs = 0.5 MDL) | 0.00 | 3.5E-04 | 3.7E-04 | 3.7E-04 | 0.615 | 0.0006 |
| LPAH sum (NDs = 0.5 MDL) | 0.00 | 2.8E-04 | 3.1E-04 | 3.1E-04 | 65.6 | 4.7E-06 |
| **Semivolatile Organic Compounds (SVOCs)** | | | | | | |
| Benzyl Alcohol | 0.00 | 9.9E-05 | 1.4E-04 | 1.4E-04 | -- | -- |
| Diethyl Phthalate | 0.00 | 2.9E-05 | 7.5E-05 | 7.5E-05 | 4583 | 1.6E-08 |
| Di-n-butyl Phthalate | 0.00 | 2.7E-05 | 3.9E-04 | 3.9E-04 | 550 | 7.2E-07 |
| Pentachlorophenol | 0.00 | 1.2E-04 | 9.6E-04 | 9.6E-04 | 8.42 | 1.1E-04 |
| Phenol | 0.00 | 2.6E-05 | 1.8E-04 | 1.8E-04 | 523 | 3.4E-07 |

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
**a.** Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per USEPA guidance (USEPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.

**Table 4-26 Summary of Chemical and Endpoint Combinations to be Evaluated in the Baseline Ecological Risk Assessment, Red Devil Mine Site**

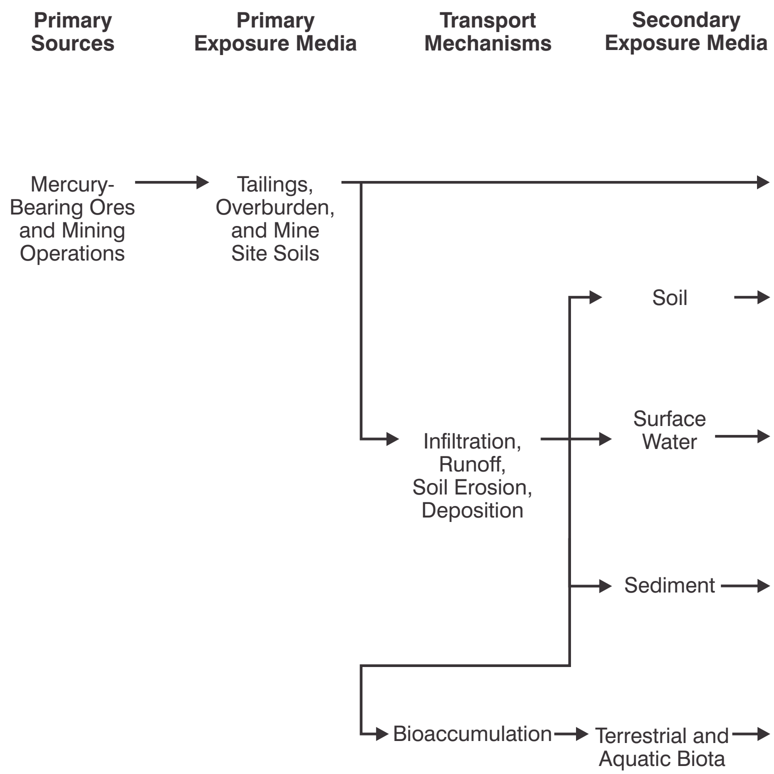
| | Assessment Endpoint and Maximum HQ[a] | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Terrestrial Wildlife[h] | | | | | | Aquatic-Dependent Wildlife[i] | | | | |
| Analyte[b] | Plants[c] | Soil Fauna[d] | Fish and Other Aquatic Biota[e] | Fish[f] | Benthos[g] | Robin | Shrew | Grouse | Vole | Shrike | Weasel | Snipe | Beaver | Teal | Kingfisher | Mink |
| **Polychlorinated Biphenyls (PCBs)** | | | | | | | | | | | | | | | | |
| Sum of Aroclors (NDs = 0.5MDL) | | x | | | | | | | | | | | | | | |
| **Metals** | | | | | | | | | | | | | | | | |
| Antimony | x | 299 | 6.1 | x | 2,193 | x | **136,370** | x | **1,681** | x | | x | **60** | x | x | **89** |
| Arsenic | 549 | x | 6.9 | 14 | 13,265 | **28** | **214** | **47** | **41** | **1.5** | **1.9** | **823** | **1.5** | **37** | **5.5** | **3.3** |
| Barium | x | 5.2 | 26 | x | x | **2.0** | **1.6** | **1.3** | | | | **1.4** | | | | |
| Beryllium | x | | | | x | x | | x | | x | | x | | x | x | |
| Cadmium | | | | | | **1.7** | **4.4** | | | | | | | | | |
| Chromium | 1.3 | x | | 3.5 | 1.1 | **2.9** | **1.3** | | | | | | | | | |
| Cobalt | 3.0 | x | | | 1.0 | | | | | | | | | | **1.1** | |
| Copper | 2.0 | 1.7 | | | 2.8 | **4.4** | **4.6** | | | | | **1.5** | | | | |
| Iron | | | 2.5 | | 16 | | | | | | | | | | | |
| Lead | 26 | 1.8 | | | | **83** | **48** | **20** | **2.8** | **4.9** | **1.0** | | | | | |
| Manganese | 19 | 9.4 | 3.2 | x | 12 | | **2.3** | **2.1** | **6.1** | | | | | | | |
| Mercury | 5,400 | 16,200 | 32 | 8 | 661 | **9.5** | **2.1** | **39** | | | | **5.8** | | **2.8** | **4.2** | |
| Methylmercury | | | | 1 | x | | | | | | | | | | **2.3** | **1.3** |
| Nickel | 2.6 | | | | 11 | **3.7** | **21** | | | | | | | | | |
| Selenium | | | | 2.7 | | | **1.2** | | | | | **5.7** | | | **5.2** | **2.9** |
| Silver | | x | | | | | | | | | | | | | | |
| Thallium | | x | | | x | x | **3.3** | x | | x | | x | | x | x | **3.8** |
| Vanadium | 26 | x | | | x | **1.9** | | **1.7** | | | | **2.5** | | | | |
| Zinc | 2.4 | 3.2 | | 1.3 | 1.1 | **2.2** | **2.7** | | | | | | | | | |
| **Polycyclic Aromatic Hydrocarbons (PAHs)** | | | | | | | | | | | | | | | | |
| HPAH sum | | | | | | | | | | | | | | | | |
| LPAH sum | | | | | | x | | x | | x | | x | | | x | |
| **Other Semivolatile Organic Compounds (SVOCs)** | | | | | | | | | | | | | | | | |
| 4-Bromophenyl phenyl ether | x | x | | | | x | x | x | x | x | x | | x | | | |
| 4-Methylphenol | x | x | | | | x | | x | | x | | | | | | |
| Benzoic acid | x | x | | | | x | x | x | x | x | x | | x | | | |
| Benzyl Alcohol | x | x | | | | x | x | x | x | x | x | x | x | | x | x |
| Bis(2-Ethylhexyl)phthalate | x | x | | | | | | | | | | | | | | |
| Dibenzofuran | | | | | | x | x | x | x | x | x | | x | | | |
| Diethylphthalate | | x | | | | x | | x | | x | | x | | | x | |
| Dimethylphthalate | x | | | | | x | x | x | x | x | x | | x | | | |
| Di-n-butyl Phthalate | | | | | | | | | | | | | | | | |
| Hexachlorobenzene | x | | | | | | | | | | | | | | | |
| Pentachlorophenol | | | | | | | | | | | | | | | | |
| Phenol | | | | | | | | | | | | | | | | |

Key:
BERA = Baseline Ecological Risk Assessment
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
TRV = toxicity reference value
Value (with or without shading) = HQ equal to or greater than 1. Chemical and receptor combination will be evaluated quantitatively in the BERA.
x = chemical detected in site samples but no screening level or TRV is available. Chemical will be evaluated qualitatively in the BERA.

Notes:
a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):

Value = > 75%
Value = 50 - 75%
Value = 25 - 50%
Value = < 25%

For wildlife, the value of the maximum HQ (exposure estimate / TRV) is shown without shading because wildlife HQs were not calculated sample-by-sample.
b. Essential nutrients (calcium, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003a). Organic chemicals detected in surface soil, sediment, or surface water are listed.
c. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on plants (see Table 4-1).
d. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on earthworms (see Table 4-1).
e. Based on comparing maximum surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see Table 4-3).
f. Based on comparing maximum whole-body sculpin chemical concentrations with fish tissue screening concentrations (see Table 4-3b).
g. Based on comparing maximum sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see Table 4-2).
h. Based on screening-level exposure estimates and hazard quotients for the American robin (Table 4-15), masked shrew (Table 4-16), spruce grouse (Table 4-17), tundra vole (Table 4-18), northern shrike (Table 4-19), and least weasel (Table 4-20).
i. Based on screening-level exposure estimates and HQs for the common snipe (Table 4-21), beaver (Table 4-22), green-winged teal (Table 4-23), belted kingfisher (Table 4-24), and mink (Table 4-25).




**Potential Ecological Receptors**

| Medium | Exposure Routes | Plants | Terrestrial Invertebrates | Birds and Mammals | Benthos | Fish and Other Aquatic Biota |
|---|---|---|---|---|---|---|
| Tailings, Overburden, and Mine Site Soils | Direct Contact | + | + | − | − | − |
| | Ingestion | − | + | + | − | − |
| Soil | Direct Contact | + | + | − | − | − |
| | Ingestion | − | + | + | − | − |
| Surface Water | Direct Contact | + | − | − | + | + |
| | Ingestion | − | − | − | + | + |
| Sediment | Direct Contact | + | − | − | + | − |
| | Ingestion | − | − | + | + | + |
| Terrestrial and Aquatic Biota | Ingestion (Food Chain) | − | + | + | + | + |

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LEGEND
+ = Complete Pathway
− = Incomplete or Insignificant Pathway

Figure 3-1
PRELIMINARY ECOLOGICAL CONCEPTUAL SITE MODEL FOR RED DEVIL MINE SITE

| Date: | Drawn by: | |
|---|---|---|
| 3/13/12 | AGM | 02:001096.0070.08TTO\Fig3-1.cdr |

# G

# Exposure Point Concentrations for Selected Media for the Baseline Ecological Risk Assessment

This appendix presents a summary of the ProUCL Version 4.1 (EPA 2010d) output generated during calculation of exposure point concentrations for surface soil, sediment, surface water, vegetation, and fish.

**Reference**

United States Environmental Protection Agency (EPA). 2010d. ProUCL Version 4.1.00 Technical Guide (Draft). EPA/600/R-07/041. May.

**Table G-1 Summary of ProUCL 4.1 Output Regarding Surface Soil Exposure Point Concentraions (EPCs) for the RDM Site BERA.**

| Data Set | Analyte | Units | Number of Observations[a] | Number of Detections | Mean of Detected | SD of Detected | Maximum Detected | Distribution (detects only) | UCL Statistic | 95% UCL | EPC | EPC Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface Soil | Antimony | mg/kg | 127 | 105 | 3,044 | 4,713 | 23,300 | Gamma | 95% KM (Chebyshev) UCL | 4,234 | 4,234 | 95% UCL |
| Surface Soil | Arsenic | mg/kg | 127 | 116 | 2,300 | 2,372 | 9,880 | Not Discernable | 97.5% KM (Chebyshev) UCL | 3,596 | 3,596 | 95% UCL |
| Surface Soil | Barium | mg/kg | 127 | 127 | 335.5 | 265.7 | 1,710 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 438.3 | 438.3 | 95% UCL |
| Surface Soil | Beryllium | mg/kg | 127 | 124 | 0.708 | 0.225 | 1.3 | Not Discernable | 95% KM (BCA) UCL | 0.734 | 0.734 | 95% UCL |
| Surface Soil | Cadmium | mg/kg | 127 | 38 | 0.541 | 0.275 | 1.3 | Lognormal | 95% KM (t) UCL | 0.321 | 0.321 | 95% UCL |
| Surface Soil | Chromium | mg/kg | 127 | 127 | 27.42 | 11.44 | 101 | Not Discernable | 95% Student's-t UCL | 29.1 | 29.1 | 95% UCL |
| Surface Soil | Colalt | mg/kg | 127 | 127 | 17.28 | 5.821 | 38.8 | Not Discernable | 95% Student's-t UCL | 18.13 | 18.13 | 95% UCL |
| Surface Soil | Copper | mg/kg | 127 | 127 | 58.84 | 26.35 | 139 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 69.03 | 69.03 | 95% UCL |
| Surface Soil | Lead | mg/kg | 127 | 118 | 48.85 | 284.4 | 3090 | Not Discernable | 95% KM (BCA) UCL | 96.56 | 96.56 | 95% UCL |
| Surface Soil | Lead - 1* | mg/kg | 126 | 117 | 22.86 | 34.04 | 220 | Not Discernable | 95% KM (BCA) UCL | 27.58 | 27.58 | 95% UCL |
| Surface Soil | Manganese | mg/kg | 127 | 127 | 696.6 | 408.2 | 4230 | Not Discernable | 95% Student's-t UCL | 756.6 | 756.6 | 95% UCL |
| Surface Soil | Manganese - 1* | mg/kg | 126 | 126 | 668.5 | 259.3 | 1,500 | Normal | 95% Student's-t UCL | 706.8 | 706.8 | 95% UCL |
| Surface Soil | Mercury | mg/kg | 127 | 127 | 196.6 | 296.1 | 1,620 | Gamma | 95% Adjusted Gamma UCL | 251.6 | 251.6 | 95% UCL |
| Surface Soil | Nickel | mg/kg | 127 | 127 | 49.99 | 16.3 | 97 | Not Discernable | 95% Student's-t UCL | 52.39 | 52.39 | 95% UCL |
| Surface Soil | Selenium | mg/kg | 127 | 2 | 0.33 | 0.127 | 0.42 | Not Discernable | 95% KM (% Bootstrap) UCL | 0.42 | 0.42 | Max Detect |
| Surface Soil | Silver | mg/kg | 127 | 2 | 0.0955 | 0.039 | 0.12 | Not Discernable | -- | -- | 0.12 | Max Detect |
| Surface Soil | Thallium | mg/kg | 127 | 2 | 0.068 | 0.00424 | 0.071 | Not Discernable | 95% KM (% Bootstrap) UCL | 0.071 | 0.071 | Max Detect |
| Surface Soil | Vanadium | mg/kg | 127 | 127 | 33.9 | 6.189 | 51.9 | Gamma | 95% Approximate Gamma UCL | 34.82 | 34.82 | 95% UCL |
| Surface Soil | Zinc | mg/kg | 127 | 127 | 104.9 | 38.65 | 386 | Not Discernable | 95% Student's-t UCL | 110.6 | 110.6 | 95% UCL |
| Surface Soil | Zinc - 1* | mg/kg | 126 | 126 | 102.6 | 29.47 | 209 | Normal | 95% Student's-t UCL | 107 | 107 | 95% UCL |

Key:
-- = not applicable or not available
ADEC = Alaska Department of Environmental Conservation
BERA = baseline ecological risk assessment
EPC = exposure point concentration
GA = green alder
KM = Kaplan-Meier
KM (BCA) UCL = UCL based on Kaplan-Meier estimate using bias-corrected accelerated bootstrap method cutoff value
mg/kg = milligrams per kilogram
RDM = Red Devil Mine
Sd = standard deviation
SD = standard deviation
UCL = upper confidence limit (on average concentration)

Notes:
* Minus 1 high outlier value.
[a] Duplicate observations resolved per ADEC guidance.

**Table G-2 Summary of ProUCL 4.1 Output Regarding Sediment (Full Dataset[a]) Exposure Point Concentraions (EPCs) for the RDM Site BERA.**

| Data Set | Analyte | Units | Number of Observations[b] | Number of Detections | Mean of Detected | SD of Detected | Maximum Detected | Distribution (detects only) | UCL Statistic | 95% UCL | EPC | EPC Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sediment | Antimony | mg/kg | 42 | 37 | 836 | 1,452 | 6,360 | Lognormal | 99% KM (Chebyshev) UCL | 2,871 | 2,871 | 95% UCL |
| Sediment | Arsenic | mg/kg | 42 | 42 | 3,709 | 19,986 | 130,000 | Not Discernable | 97.5% Chebyshev (Mean, Sd) UCL | 22,968 | 22,968 | 95% UCL |
| Sediment | Barium | mg/kg | 42 | 42 | 254.1 | 327.1 | 1,990 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 474.1 | 474.1 | 95% UCL |
| Sediment | Beryllium | mg/kg | 42 | 42 | 0.624 | 1.028 | 7 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 1.316 | 1.316 | 95% UCL |
| Sediment | Chromium | mg/kg | 42 | 41 | 20.43 | 8.347 | 47.4 | Normal | 95% KM (t) UCL | 22.56 | 22.56 | 95% UCL |
| Sediment | Cobalt | mg/kg | 42 | 42 | 12.7 | 7.446 | 50 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 17.71 | 17.71 | 95% UCL |
| Sediment | Copper | mg/kg | 42 | 42 | 30.14 | 16.42 | 87.5 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 41.19 | 41.19 | 95% UCL |
| Sediment | Iron | mg/kg | 42 | 42 | 39,129 | 48,829 | 344,000 | Not Discernable | 95% Student's-t UCL | 51,808 | 51,808 | 95% UCL |
| Sediment | Manganese | mg/kg | 42 | 42 | 1,071 | 855.7 | 5,410 | Gamma | 95% Approximate Gamma UCL | 1,256 | 1,256 | 95% UCL |
| Sediment | Mercury | mg/kg | 42 | 42 | 23.11 | 30.63 | 119 | Gamma | 95% Adjusted Gamma UCL | 36.1 | 36.1 | 95% UCL |
| Sediment | Methyl Mercury | µg/kg | 30 | 29 | 1.375 | 2.82 | 14.4 | Lognormal | 97.5% KM (Chebyshev) UCL | 4.505 | 4.505 | 95% UCL |
| Sediment | Nickel | mg/kg | 42 | 42 | 39.77 | 34.98 | 240 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 63.3 | 63.3 | 95% UCL |
| Sediment | Selenium | mg/kg | 41 | 27 | 0.463 | 0.365 | 2.11 | Not Discernable | 95% KM (BCA) UCL | 0.592 | 0.592 | 95% UCL |
| Sediment | Thallium | mg/kg | 41 | 28 | 0.139 | 0.129 | 0.653 | Not Discernable | 95% KM (BCA) UCL | 0.185 | 0.185 | 95% UCL |
| Sediment | Vanadium | mg/kg | 42 | 42 | 25.41 | 8.178 | 48.5 | Normal | Use 95% Student's-t UCL | 27.53 | 27.53 | 95% UCL |
| Sediment | Zinc | mg/kg | 42 | 42 | 79.37 | 24.56 | 132 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 95.89 | 95.89 | 95% UCL |
| Sediment | Antimony - YBS | mg/kg | 41 | 36 | 815 | 1,467 | 6,360 | Lognormal | 99% KM (Chebyshev) UCL | 2,893 | 2,893 | 95% UCL |
| Sediment | Arsenic - YBS | mg/kg | 41 | 41 | 629 | 981 | 3,610 | Lognormal | 97.5% Chebyshev (Mean, Sd) UCL | 1,585 | 1,585 | 95% UCL |
| Sediment | Barium - YBS | mg/kg | 41 | 41 | 211.7 | 180.3 | 985 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 334.5 | 334.5 | 95% UCL |
| Sediment | Beryllium - YBS | mg/kg | 41 | 41 | 0.469 | 0.204 | 0.9 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 0.607 | 0.607 | 95% UCL |
| Sediment | Chromium - YBS | mg/kg | 41 | 41 | 20.43 | 8.347 | 47.4 | Normal | 95% Student's-t UCL | 22.63 | 22.63 | 95% UCL |
| Sediment | Cobalt - YBS | mg/kg | 41 | 41 | 11.79 | 4.605 | 22.3 | Normal | 95% Student's-t UCL | 13.01 | 13.01 | 95% UCL |
| Sediment | Copper - YBS | mg/kg | 41 | 41 | 30.15 | 16.63 | 87.5 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 41.46 | 41.46 | 95% UCL |
| Sediment | Iron - YBS | mg/kg | 41 | 41 | 31,693 | 7,973 | 55,600 | Gamma | 95% Approximate Gamma UCL | 33,795 | 33,795 | 95% UCL |
| Sediment | Manganese - YBS | mg/kg | 42 | 42 | 1,071 | 855.7 | 5,410 | Gamma | 95% Approximate Gamma UCL | 1,256 | 1,256 | 95% UCL |
| Sediment | Mercury - YBS | mg/kg | 41 | 41 | 23.46 | 30.92 | 119 | Gamma | 95% Adjusted Gamma UCL | 37.04 | 37.04 | 95% UCL |
| Sediment | Methyl Mercury - YBS | µg/kg | 29 | 28 | 0.91 | 1.318 | 7.02 | Gamma | 95% KM (Chebyshev) UCL | 1.938 | 1.938 | 95% UCL |
| Sediment | Nickel - YBS | mg/kg | 41 | 41 | 34.89 | 15.08 | 67 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 45.15 | 45.15 | 95% UCL |
| Sediment | Selenium - YBS | mg/kg | 41 | 27 | 0.463 | 0.365 | 2.11 | Not Discernable | 95% KM (BCA) UCL | 0.588 | 0.588 | 95% UCL |
| Sediment | Thallium - YBS | mg/kg | 41 | 28 | 0.139 | 0.129 | 0.653 | Not Discernable | 95% KM (BCA) UCL | 0.183 | 0.183 | 95% UCL |
| Sediment | Vanadium - YBS | mg/kg | 41 | 41 | 25.54 | 8.234 | 48.5 | Normal | 95% Student's-t UCL | 27.71 | 27.71 | 95% UCL |
| Sediment | Zinc - YBS | mg/kg | 41 | 41 | 78.38 | 24 | 132 | Normal | 95% Student's-t UCL | 84.69 | 84.69 | 95% UCL |

Key:
ADEC = Alaska Department of Environmental Conservation
BERA = baseline ecological risk assessment
EPC = exposure point concentration
KM = Kaplan-Meier
KM (BCA) UCL = UCL based on Kaplan-Meier estimate using bias-corrected accelerated bootstrap method cutoff value
mg/kg = milligrams per kilogram
RDM = Red Devil Mine
Sd = standard deviation
SD = standard deviation
UCL = upper confidence limit (on average concentration)
YBS = yellow boy sample (refers to sediment sample 10RD05SD, which was a sample of iron oxyhydroxide precipitate from the spring in the Main Processing Area)

Note:
[a] See Human Health Risk Assesment (HHRA) tables for sediment EPCs based only on Red Devil Creek and near-shore Kuskokwim River sediment samples.
[b] Duplicate observations resolved per ADEC guidance.

**Table G-3 Summary of ProUCL 4.1 Output Regarding Unfiltered Surface Water Exposure Point Concentraions (EPCs) for the RDM Site BERA**

| Data Set | Analyte | Units | Number of Observations[a] | Number of Detections | Mean of Detected | SD of Detected | Maximum Detected | Distribution (detects only) | UCL Statistic | 95% UCL | EPC | EPC Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surface Water | Antimony | ug/L | 19 | 19 | 72.72 | 72.6 | 184 | Gamma | 95% Approximate Gamma UCL | 135.5 | 135.5 | 95% UCL |
| Surface Water | Arsenic | ug/L | 19 | 19 | 138.1 | 294.9 | 1030 | Not Discernable | 99% Chebyshev (Mean, Sd) UCL | 811.3 | 811.3 | 95% UCL |
| Surface Water | Arsenic - 2* | ug/L | 178 | 17 | 40.61 | 38.38 | 85.6 | Not Discernable | 99% Chebyshev (Mean, Sd) UCL | 133.2 | 85.6 | Max Detect |
| Surface Water | Barium | ug/L | 19 | 19 | 34.02 | 24.36 | 103 | Not Discernable | 95% Student's-t UCL | 43.71 | 43.71 | 95% UCL |
| Surface Water | Barium - 2* | ug/L | 17 | 17 | 25.96 | 3.519 | 32.1 | Normal | 95% Student's-t UCL | 27.45 | 27.45 | 95% UCL |
| Surface Water | Beryllium | ug/L | 19 | 1 | 0.009 | -- | 0.009 | Insufficient Data | Insufficient Data | -- | 0.009 | Max Detect |
| Surface Water | Cadmium | ug/L | 19 | 3 | 0.00633 | 0.00153 | 0.008 | Normal | 95% KM (t) UCL | 0.00593 | 0.00593 | 95% UCL |
| Surface Water | Chromium | ug/L | 19 | 11 | 0.325 | 0.135 | 0.57 | Normal | 95% KM (t) UCL | 0.306 | 0.306 | 95% UCL |
| Surface Water | Cobalt | ug/L | 19 | 16 | 0.844 | 1.735 | 5.3 | Not Discernable | 97.5% KM (Chebyshev) UCL | 3.039 | 3.039 | 95% UCL |
| Surface Water | Cobalt - 2* | ug/L | 17 | 14 | 0.211 | 0.166 | 0.677 | Gamma | 95% KM (BCA) UCL | 0.248 | 0.248 | 95% UCL |
| Surface Water | Copper | ug/L | 19 | 12 | 0.438 | 0.116 | 0.71 | Normal | 95% KM (t) UCL | 0.431 | 0.431 | 95% UCL |
| Surface Water | Iron | ug/L | 19 | 19 | 507.6 | 817.4 | 2470 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 1325 | 1325 | 95% UCL |
| Surface Water | Iron - 2* | ug/L | 17 | 17 | 299.6 | 560 | 2470 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 891.7 | 891.7 | 95% UCL |
| Surface Water | Lead | ug/L | 19 | 11 | 0.0242 | 0.0195 | 0.079 | Gamma | 95% KM (t) UCL | 0.0344 | 0.0344 | 95% UCL |
| Surface Water | Manganese | ug/L | 19 | 19 | 61.93 | 108.6 | 379 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 170.6 | 170.6 | 95% UCL |
| Surface Water | Manganese - 2* | ug/L | 17 | 17 | 26.1 | 17.3 | 86.4 | Gamma | 95% Approximate Gamma UCL | 33.2 | 33.2 | 95% UCL |
| Surface Water | Mercury | **ng/L** | 18 | 18 | 128.6 | 132 | 385 | Gamma | 95% Approximate Gamma UCL | 242.5 | 242.5 | 95% UCL |
| Surface Water | Methylmercury | **ng/L** | 18 | 18 | 0.162 | 0.147 | 0.62 | Not Discernable | 95% Chebyshev (Mean, Sd) UCL | 0.313 | 0.313 | 95% UCL |
| Surface Water | Methylmercury - 2* | **ng/L** | 16 | 16 | 0.113 | 0.0246 | 0.144 | Gamma | 95% Approximate Gamma UCL | 0.125 | 0.125 | 95% UCL |
| Surface Water | Nickel | ug/L | 19 | 16 | 3.05 | 5.917 | 19.2 | Not Discernable | 97.5% KM (Chebyshev) UCL | 10.54 | 10.54 | 95% UCL |
| Surface Water | Nickel - 2* | ug/L | 17 | 14 | 0.893 | 0.374 | 1.38 | Not Discernable | 95% KM (Chebyshev) UCL | 1.222 | 1.222 | 95% UCL |
| Surface Water | Selenium | ug/L | 19 | 8 | 0.425 | 0.0707 | 0.5 | Normal | 95% KM (t) UCL | 0.385 | 0.385 | 95% UCL |
| Surface Water | Thallium | ug/L | 19 | 2 | 0.0085 | 0.00212 | 0.01 | Not Discernable | 95% KM (t) UCL | 0.00753 | 0.00753 | 95% UCL |
| Surface Water | Vanadium | ug/L | 19 | 11 | 0.142 | 0.0334 | 0.22 | Normal | 95% KM (t) UCL | 0.137 | 0.137 | 95% UCL |
| Surface Water | Zinc | ug/L | 19 | 8 | 0.763 | 0.715 | 2.1 | Not Discernable | 95% KM (t) UCL | 0.727 | 0.727 | 95% UCL |

Key:
-- = not applicable or not available
ADEC = Alaska Department of Environmental Conservation
BERA = baseline ecological risk assessment
EPC = exposure point concentration
KM = Kaplan-Meier
KM (BCA) UCL = UCL based on Kaplan-Meier estimate using bias-corrected accelerated bootstrap method cutoff value
ng/L = nanograms per liter
RDM = Red Devil Mine
Sd = standard deviation
SD = standard deviation
UCL = upper confidence limit (on average concentration)
ug/L = micrograms per liter

Notes:
* Minus two samples from the spring in the Main Processing Area (10RD05SW and 11RD05SW).
[a] Duplicate observations resolved per ADEC guidance.

**Table G-4 Summary of ProUCL 4.1 Output Regarding Green Alder (GA) Bark and Spruce Needle Exposure Point Concentraions (EPCs) for the RDM Site BERA.**

| Data Set | Analyte | Units | Number of Observations | Number of Detections | Mean of Detected | SD of Detected | Maximum Detected | Distribution (detects only) | UCL Statistic | UCL | EPC | EPC Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GA Bark | Antimony | mg/kg | 8 | 8 | 1.236 | 1.219 | 3.35 | Gamma | 95% Approximate Gamma UCL | 2.724 | 2.724 | 95% UCL |
| GA Bark | Arsenic | mg/kg | 8 | 8 | 0.355 | 0.264 | 0.91 | Normal | 95% Student's-t UCL | 0.532 | 0.532 | 95% UCL |
| Spruce | Antimony | mg/kg | 8 | 8 | 2.377 | 5.151 | 15.1 | Lognormal | 95% Chebyshev (Mean, Sd) UCL | 10.32 | 10.32 | 95% UCL |
| Spruce | Arsenic | mg/kg | 8 | 8 | 1.728 | 3.796 | 11.1 | Lognormal | 95% Chebyshev (Mean, Sd) UCL | 7.577 | 7.577 | 95% UCL |
| Spruce | Barium | mg/kg | 8 | 8 | 41.05 | 28.12 | 85.3 | Normal | 95% Student's-t UCL | 59.88 | 59.88 | 95% UCL |
| Spruce | Beryllium | mg/kg | 8 | 2 | 0.008 | 0 | 0.008 | Unknown | Insufficient Data | -- | 0.008 | Max Detect |
| Spruce | Lead | mg/kg | 8 | 8 | 0.102 | 0.151 | 0.466 | Lognormal | 95% Chebyshev (Mean, Sd) UCL | 0.335 | 0.335 | 95% UCL |
| Spruce | Managanese | mg/kg | 8 | 8 | 923 | 927.5 | 2990 | Gamma | 95% Approximate Gamma UCL | 1904 | 1904 | 95% UCL |
| Spruce | Mercury | mg/kg | 8 | 8 | 0.959 | 1.923 | 5.64 | Gamma | 95% Adjusted Gamma UCL | 5.694 | 5.64 | Max Detect |
| Spruce | Thallium | mg/kg | 8 | 2 | 0.013 | 0.0113 | 0.021 | Not Discernable | 95% KM (BCA) UCL | 0.021 | 0.021 | Max Detect |
| Spruce | Vanadium | mg/kg | 8 | 8 | 0.113 | 0.157 | 0.47 | Not Discernable | 95% Hall's Bootstrap UCL | 0.917 | 0.47 | Max Detect |

Key:
BERA = baseline ecological risk assessment
EPC = exposure point concentration
GA = green alder
KM (BCA) UCL = UCL based on Kaplan-Meier estimate using bias-corrected accelerated bootstrap method cutoff value
mg/kg = milligrams per kilogram
RDM = Red Devil Mine
Sd = standard deviation
SD = standard deviation
UCL = upper confidence limit (on average concentration)

**Table G-5 Summary of ProUCL 4.1 Output Regarding Whole-Body Slimy Sculpin Exposure Point Concentraions (EPCs) for the RDM Site BERA.**

| Data Set | Analyte | Units | Number of Observations | Number of Detections | Mean | SD | Maximum | Distribution | UCL Statistic | 95% UCL | EPC | EPC Source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fish Tissue (Sculpin) | Antimony | mg/kg wet | 21 | 21 | 10.6 | 10.18 | 38.1 | Gamma | 95% Approximate Gamma UCL | 17.06 | 17.06 | 95% UCL |
| Fish Tissue (Sculpin) - June | Antimony | mg/kg wet | 9 | 9 | 1.472 | 1.123 | 4.044 | Normal | 95% Student's-t UCL | 2.168 | 2.168 | 95% UCL |
| Fish Tissue (Sculpin) - August | Antimony | mg/kg wet | 12 | 12 | 17.45 | 8.253 | 38.1 | Normal | 95% Student's-t UCL | 21.73 | 21.73 | 95% UCL |
| Fish Tissue (Sculpin) | Arsenic | mg/kg wet | 21 | 21 | 8.823 | 6.841 | 24.06 | Normal | 95% Student's-t UCL | 11.4 | 11.4 | 95% UCL |
| Fish Tissue (Sculpin) - June | Arsenic | mg/kg wet | 9 | 9 | 2.457 | 1.12 | 4.493 | Normal | 95% Student's-t UCL | 3.151 | 3.151 | 95% UCL |
| Fish Tissue (Sculpin) - August | Arsenic | mg/kg wet | 12 | 12 | 13.6 | 5.115 | 24.06 | Normal | 95% Student's-t UCL | 16.25 | 16.25 | 95% UCL |
| Fish Tissue (Sculpin) | Mercury | mg/kg wet | 21 | 21 | 1.288 | 1.256 | 3.701 | Gamma | 95% Approximate Gamma UCL | 2.14 | 2.14 | 95% UCL |
| Fish Tissue (Sculpin) - June | Mercury | mg/kg wet | 9 | 9 | 0.16 | 0.184 | 0.63 | Lognormal | 95% H-UCL | 0.331 | 0.331 | 95% UCL |
| Fish Tissue (Sculpin) - August | Mercury | mg/kg wet | 12 | 12 | 2.134 | 1.012 | 3.701 | Normal | 95% Student's-t UCL | 2.659 | 2.659 | 95% UCL |
| Fish Tissue (Sculpin) | Selenium | mg/kg wet | 21 | 21 | 1.66 | 0.614 | 2.975 | Normal | 95% Student's-t UCL | 1.891 | 1.891 | 95% UCL |
| Fish Tissue (Sculpin) - June | Selenium | mg/kg wet | 9 | 9 | 1.076 | 0.204 | 1.43 | Normal | 95% Student's-t UCL | 1.202 | 1.202 | 95% UCL |
| Fish Tissue (Sculpin) - August | Selenium | mg/kg wet | 12 | 12 | 2.099 | 0.406 | 2.975 | Normal | 95% Student's-t UCL | 2.309 | 2.309 | 95% UCL |

Key:
ADEC = Alaska Department of Environmental Conservation
BERA = baseline ecological risk assessment
EPC = exposure point concentration
H = H statistic
mg/kg = milligrams per kilogram
RDM = Red Devil Mine
Sd = standard deviation
SD = standard deviation
UCL = upper confidence limit (on average concentration)