# Bureau of Land Management Record of Decision

Red Devil Mine, Alaska

May 2022

UNITED STATES DEPARTMENT OF THE INTERIOR BUREAU OF LAND MANAGEMENT ANCHORAGE FIELD OFFICE 4700 BLM Road Anchorage, Alaska 99507



### Red Devil Mine Record of Decision

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# LIST OF ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
ARAR	Applicable or Relevant and Appropriate Requirement
AST	aboveground storage tank
BERA	Baseline Ecological Risk Assessment
BGS	below ground surface
BLM	Bureau of Land Management
BSAF	biota sediment accumulation factor
BSWI	Bering Sea – Western Interior
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of
	1980, as amended
CFR	Code of Federal Regulations
cfs	cubic feet per second
COC	contaminant of concern
COPC	contaminants of potential concern
DNR	Alaska Department of Natural Resources
DOI	U.S. Department of the Interior
DRO	diesel-range organics
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
FCM	food chain multiplier
FS	Feasibility Study
GTC	Georgetown Tribal Council
HHRA	Human Health Risk Assessment
HQ	hazard quotient
IC	institutional control
KAP	Kuskokwim Action Plan
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
O&M	operation and maintenance
PCB	polychlorinated biphenyl
RAO	Remedial Action Objective
RBCL	risk-based concentration level
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RME	reasonable maximum exposure
RMP	Resource Management Plan
ROD	Record of Decision

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RRO	residual-range organics
SVOC	semi-volatile organic compound
TBC	Other Factors to Be Considered
TCLP	toxicity characteristic leaching procedure
TKC	The Kuskokwim Corporation
TTF	trophic transfer factor
UCL	upper confidence limit
USC	United States Code
USGS	U.S. Geological Survey

# **PART I – DECLARATION**

#### Site Name and Location

Red Devil Mine BLM-managed land near Red Devil Village, Alaska

#### **Statement of Basis and Purpose**

This Record of Decision (ROD) presents the Selected Remedy for tailings/waste rock, soil, Red Devil Creek sediments, Kuskokwim River sediments, and site groundwater at the Red Devil Mine, Alaska.

This document was prepared by the U.S. Department of the Interior (DOI) - Bureau of Land Management (BLM), the lead agency for response activities on public land at the Red Devil Mine. By Executive Order 12580, the President has delegated authority to the DOI to respond to any release or threatened release of a hazardous substance, or pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare, on or from land under the DOI's jurisdiction, custody, or control, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended (CERCLA; 42 United States Code [USC] §§ 9601 et. seq.), as implemented by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 Code of Federal Regulations (CFR) Part 300. The Secretary of the Interior has further delegated this CERCLA response authority to the Director of the BLM for land under the BLM's jurisdiction. Under this authority, the BLM has investigated the nature and extent of contamination resulting from the release and threatened release of hazardous substances at or from the Red Devil Mine and implemented early actions to protect public health and welfare and the environment from risks associated with these releases prior to selection of long-term remedies at the site. The decision to select the Remedial Action described in this ROD is based on the administrative record for the Red Devil Mine, available at the BLM Anchorage, Alaska Field Office, and available online at:

https://www.ak.blm.gov/red\_devil\_mine/Red\_Devil\_Mine\_Admin\_Record.html.

As the lead agency under CERCLA for the Red Devil Mine cleanup, BLM is authorized to plan and implement response actions to identify the existence of releases and threatened releases of hazardous substances, characterize the nature and extent of such releases and threatened releases, and undertake any other response actions that the BLM deems necessary to protect public health or welfare or the environment from risks associated with such releases and threatened releases. The BLM identified a preferred remedial alternative for responding to hazardous substances in tailings/waste rock, soil, Red Devil Creek sediments, Kuskokwim River sediments, and site groundwater at the Red Devil Mine in a Proposed Plan issued for public comment on March 1, 2020. The BLM analyzed the remedial alternatives considering the scope and complexity of site conditions and the criteria set forth in Section 300.430 of the NCP. The Selected Remedy described in this ROD was selected after the BLM fully reviewed and considered all information provided by the State of Alaska, the U.S. Environmental Protection Agency Region 10 (EPA),

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and local communities during the public comment period for the Proposed Plan, as well as all information contained in the administrative record for the Red Devil Mine.

#### Assessment of the Site

The Selected Remedy presented in this ROD is necessary to protect the public health and welfare and the environment from actual or threatened releases of hazardous substances into the environment. Samples of mine tailings/waste rock, soil, Red Devil Creek sediments, Kuskokwim River sediments, and groundwater collected from the Red Devil Mine contained concentrations of contaminants of concern (COCs), including antimony, arsenic, and mercury, at levels significantly above local background values. Based on the Human Health Risk Assessment (HHRA) conducted for the Red Devil Mine, concentrations of antimony, arsenic, and mercury pose unacceptable cancer and noncancer human health risks to potential future residents and recreational users of the site. Based on the Baseline Ecological Risk Assessment (BERA) conducted for the Red Devil Mine, antimony, arsenic, and mercury also pose unacceptable risks to terrestrial and aquatic wildlife and vegetation.

#### **Description of the Selected Remedy**

The Selected Remedy for the Red Devil Mine is Alternative SW3C. This alternative includes the following elements:

- Excavating contaminated tailings/waste rock, soil, and sediments in Red Devil Creek at the site, including Monofill #2;
- Excavating nearshore sediments in the Kuskokwim River, located downstream of the Red Devil Creek delta;
- Treatment using solidification of tailings/waste rock excavated from the Main Processing Area and Monofill #2 that failed the TCLP test for arsenic;
- Consolidating appropriate excavated materials into an engineered repository and disposing of materials not appropriate for the repository at an appropriate facility;
- Long-term maintenance of the engineered repository and monitoring groundwater;
- Capping exposed highly mineralized areas in the Surface Mined Area;
- Long-term monitoring of groundwater in the Red Devil Creek watershed;
- Monitoring of Kuskokwim River sediments to verify remedy effectiveness; and
- Installing exclusion fencing to protect wildlife and implementing restrictions on public access and future use of the site area.

#### **Overall Cleanup Strategy**

The primary sources of contamination at the Red Devil Mine include tailings and waste rock that were disposed of during past mining operations. Antimony, arsenic, and mercury have collectively been identified as the main risk driver in both the HHRA and the BERA (E & E 2015). The Selected Remedy is intended to reduce actual and potential human and ecological exposure to tailings/waste rock, soil, and creek sediments containing metals at concentrations that exceed remedial goals (see Section 8.3). Reduction of human exposure to hazardous substances at the Red Devil Mine will be accomplished through institutional controls (ICs),

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removal and consolidation of contaminated materials within the Main Processing Area portion of the site, and prevention or minimization of migration of COCs using stormwater controls.

#### **Statutory Determination**

The Selected Remedy is protective of human health and the environment, is cost-effective, and utilizes permanent solutions to the maximum extent practicable. The Selected Remedy also uses treatment that permanently and significantly reduces the mobility of hazardous substances. The Selected Remedy also complies with applicable or relevant and appropriate federal and state requirements (ARARs) identified by BLM as the lead agency under CERCLA. BLM considered a wide range of regulations to guide implementation of the alternative site remedies evaluated and coordinated closely with the State of Alaska to develop the final list of applicable requirements for cleanup of the site.

Because the Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unrestricted future use, the BLM will conduct a review pursuant to CERCLA Section 121(c) and NCP Section 300.430(f)(4)(ii), no less often than every five years after initiation of the Selected Remedy, to ensure that the remedy is protective of human health and the environment.

#### **Data Certification Checklist**

The following information is included in the Decision Summary (Part II) of this ROD:

- COCs and their respective concentrations (see Section 5.4, and Appendix A);
- Baseline risk presented by the COCs (see Sections 7.2 and 7.3);
- Cleanup levels established for COCs and the basis for these levels (see Section 8);
- Current and reasonably anticipated future land use assumptions (see Sections 6.1 and 6.2);
- Estimated capital, annual operation and maintenance, and total present-worth costs, discount rate, and the number of years over which the remedy cost estimates are projected (see Section 10.2.5); and
- Key factor(s) that led to selecting the remedy (see Section 12.1).

Additional information is available in the administrative record for the Red Devil Mine.

#### **Authorizing Signature**

Date

# PART II – DECISION SUMMARY

# 1.0 SITE NAME, LOCATION, AND DESCRIPTION

The Red Devil Mine is an abandoned mercury mine located approximately 250 air miles west of Anchorage, Alaska, on the southwest bank of the Kuskokwim River, approximately 2 miles southeast of the village of Red Devil (see Figure 1-1). The site is located in Township 19 North, Range 44 West, and in portions of Sections 5, 6, 7, and 8 of the Seward Meridian. The site's approximate coordinates are 61° 45′ 38.1″ north latitude, and 157° 18′ 42.7″ west longitude. The site is entirely situated within U.S. Survey No. 14428 and covers approximately 190 acres.

The site is in a remote location with no road or rail connections to any communities or the state highway system. The site is accessed by boat or barge on the Kuskokwim River, by aircraft via a 6,000-foot airstrip adjacent to Red Devil Village. Site access from the airstrip is via an all-terrain vehicle trail over a distance of approximately 2 miles (see Figure 1-1).

For the RI/FS, the site was divided into two primary geographic areas. These areas are illustrated on Figure 1-2 and include:

- Main Processing Area. This is the area where all mineral processing occurred during the mine's operational years. Most of the former site structures were located in this area. Nearly all of the processed ore tailings and waste rock were disposed of within and adjacent to the Main Processing Area. Red Devil Creek flows through the Main Processing Area, and empties into the Kuskokwim River approximately 1,000 feet downstream of the center of the Main Processing Area. The Main Processing Area also includes the location of the former aboveground storage tanks (ASTs) where petroleum fuels were stored for mining and milling operations. Petroleum-contaminated soils excavated from this area were placed in a landspread area in the northern portion of the Main Processing Area.
- Surface Mined Area. This is the area west and uphill of the Main Processing Area where surficial ore exploration and mining was conducted. The Surface Mined Area is underlain by extensive underground mine workings, including several closed openings used to access underground tunnels. Features consisting of soil and pieces of mineralized bedrock, known as the "Dolly Sluice" and "Rice Sluice," are also associated with mining within the Surface Mined Area. The area is presently overgrown with dense underbrush and trees.

This ROD describes remediation targeting the large volume of tailings and waste rock in the Main Processing Area that contains antimony, arsenic, mercury, and other metals at levels that exceed remedial goals. It also targets "Monofill #2" which is a structure created by the BLM to contain building and mine processing equipment and soil impacted by tailings.





Image Source: Aero-Metric, Inc. 2010a

# 2.0 SITE HISTORY AND RESPONSE ACTIVITIES

The following sections describe the Red Devil Mine's history, as well as past site investigations and response activities.

### 2.1 Mining History

Mercury ore was discovered in the Red Devil Creek drainage in 1933. The claim was located according to the Mining Law of 1872, which allowed the BLM minimal authority to regulate mining-related activities. Most of the information below is based on historical research performed by the BLM. By 1939, mercury ore was mined from creek sediments and overburden. The highly mineralized ore zone contained naturally high levels of arsenic and antimony, in addition to mercury.

In the early 1940s, mining activity shifted to underground extraction. The ore zones were accessed through two adits and a main shaft in what is now called the Main Process Area, on the northwest side of Red Devil Creek. During this initial period of underground ore extraction, a 40-ton rotary kiln was installed inside a log structure referred to as the "Pre-1955 Rotary Furnace Building. Mercury ore was heated to approximately 700 degrees, which is sufficient to sublimate, or force the mercury to transition from solid to vapor. The mercury-laden vapor cools as the gases pass through a pipe directing exhaust from the top of the kiln. Elemental mercury (quicksilver) condenses from the cooling vapor and is collected in flasks. This process is referred to as retorting, which does not generate a temperature within the kiln sufficient to melt the ore. The processed ore is referred to as .burnt ore, or tailings, which were deposited outside of the Pre-1955 Rotary Furnace Building into the drainage channel of Red Devil Creek. Waste rock (mined bedrock with insufficient mineralization to warrant processing or sub-grade ore) was piled adjacent to the tailings.

In October 1954, a fire destroyed a large portion of the mine surface structures and equipment, including the Pre-1955 Rotary Furnace Building. Following the 1954 fire, a modern mercury furnace was built on the southeast side of Red Devil Creek, referred to as the "Post-1955 Retort Building." Tailings and waste rock were disposed of outside the both the pre- and post-1955 processing buildings. Over time, tailings and waste rock were buildozed downslope and into the Red Devil Creek to make space for additional processed tailings. Underground mining ceased in the late 1950's due to a failing mercury market and increasing difficulty managing groundwater in the underground workings.

Extensive surface exploration and mining continued after 1956. A water reservoir was created after 1956, which was constructed with an earthen dam across Red Devil Creek upgradient of the actively mined area. The reservoir was likely constructed to provide a source of water for the hydraulic sluicing operations such as those conducted at the "Dolly Sluice Area," where loose overburden was washed through a sluice to recover ore. The waste material from the sluice operation was washed down a gully toward the Kuskokwim River. This resulted in the formation of the Dolly Sluice Area (see Figure 1-2) delta on the Kuskokwim River at the base of the gully.

In 1960's, the mine operated sporadically. The last period of full scall mining was in 1969, when operations included both open pit and underground mining. Surface mining was conducted over a large area on the hillside northwest of the process area(the Surface Mine Area) by trenching,

bulldozing, pit excavation, and sluicing. After 1969, cinnabar and stibnite concentrates were produced using a flotation process. The ball mill and flotation mill were installed in an addition to the the Post-1955 Retort Building. The flotation process involved use of various chemicals, including "pine oil," lead acetate, and Dowfroth 250. Tailings from the flotation unit were moved from the flotation mill into three settling ponds north of the Post-1955 Retort Building via a wooden chute. The flotation mill operated for most of 1970. The mine closed in June 1971 due to a drop in the price of mercury. A caretaker remained on the mine site for several months to maintain process equipment and pumps used to dewater underground workings. The mine was abandoned later in 1971.

A company named Alaska Mines and Minerals, Inc., was the last operator of the mine and assumed ownership of the claims in 1969. There has not been any production at the mine since 1971, and the company is no longer in existence. The claimants for the mining claims associated with the site failed to file necessary information to maintain their claims in the late 1980s, and the BLM issued decisions concluding that the claims were abandoned in the late 1980s and early 1990s. The BLM was not able to locate a responsible party to assist with cleanup.

#### 2.2 Waste Generation and Disposal

Wastes generated by mining operations consist primarily of waste rock, surface mining spoils, and processed ore tailings. Waste rock included the overburden material that resulted from surface mining processes and sub-ore-grade material generated during underground mining activities. Based on a 1941 photograph, at least some waste rock was disposed of in dumps near mine openings and some of the waste rock was deposited in the Red Devil Creek drainage.

During later surface mining activities, soil overburden was bulldozed into steep piles in the Surface Mine Area. The soil overburden, which contained pieces of mineralized bedrock, was pushed through a natural ravine in the bluff and onto the river shore. The ravine acted as a sluice, forcing the material into a concentrated pile, forming the Dolly and Rice ore zone areas on the riverbank. Wastes generated from sluicing locally accumulated in deposits, including the Dolly Sluice Area delta. A second sluice delta I may have formed as a result of sluicing the overburden through a different ravine in the bluff.

Tailings are comprised of thermally processed ore that mixed with the waste rock after it was discharged from the retort facility. Over much of the history of mining and ore processing at the site, tailings were moved into the Red Devil Creek channel and down toward the river to keep the ore processing areas clear.

#### 2.3 Preliminary Studies and Response Actions

Environmental investigations and response actions have been conducted at Red Devil Mine since the early 1970s. The most significant of these activities are summarized below.

**1971 U.S. Environmental Protection Agency Study.** This was the first sampling investigation at the site. While the flotation mill was operating, the EPA collected surface water samples from Red Devil Creek, one of the settling ponds, and the Kuskokwim River. Concentrations of mercury and arsenic that were higher than background values were detected in the creek water

and the settling pond; however, sampling results from Kuskokwim River water were inconclusive.

**1989 Site Inspection.** A Comprehensive Environmental Response, Compensation, and Liability Act o(CERCLA) site inspection was performed at the site on behalf of the United States Department of the Interior - Bureau of Land Management (BLM) in 1988. The site inspection involved collecting samples from tailings, surface water, and sediment in Red Devil Creek and sediment in the settling ponds. Results of the sampling indicated the presence of antimony, arsenic, mercury, and lead in tailings, creek sediments, and in soils near the settling ponds in concentrations higher than background values.

**1999 Limited Waste Removal Action.** In 1999, the BLM conducted limited waste removal and site characterization activities to address the most hazardous conditions observed at the site during the 1989 inspection. As part of this action, over 100 lead batteries and over 25 drums containing waste oil, solvents, and grease were collected and shipped off site for disposal. Several cubic yards of contaminated debris, including ash and concrete, were also removed from the Post-1955 Retort Building and shipped off site for disposal. Sampling included collection of background soil samples and samples from known contaminant source areas in the Main Processing Area, Red Devil Creek, and the Kuskokwim River. Contaminants were detected above Alaska soil cleanup standards in samples from multiple locations around sources in the Main Processing Area, including areas where drums of chemicals had been stored and near the foundation of the Post-1955 Retort Building.

**2001 Source Area Removal and Investigation.** This phase of site cleanup involved asbestos abatement, demolition of structures, plugging of mine shafts, environmental sampling in the Main Processing Area and removal of contaminated material for off-site disposal. Soil borings and monitoring wells were installed in the Main Processing Area. Nine subsurface borings were drilled and sampled, and five were completed as monitoring wells. Surface and near-surface soil samples collected from soil borings contained antimony, arsenic, and mercury at concentrations exceeding background concentrations, consistent with the results of previous investigations.

The results of a soils investigation performed around the Post-1955 Retort Building slab indicated the presence of mercury in concentrations above background in surface and subsurface soils. Elemental mercury (quicksilver) was observed in samples from five soil borings on the west side of the building slab at depths between 2 and 6 feet below ground surface (BGS).

**2002 Debris Consolidation and Disposal Project.** In 2002, the BLM demolished several on-site structures, most of which were cleared of hazardous substances in 1999 (see "1999 Limited Waste Removal Action" above). Approximately 4,400 cubic yards of "inert debris" was placed within Monofill #1. The inert debris consisted of building debris, wood, concrete, scrap metal, 23 transformers (none contained oil), and non-friable asbestos-containing material. Compacted inert debris was capped with 2 feet of soil and contoured so that it blended with the existing grade.

Monofill #2 was constructed during the 2002 project phase to contain material generated by demolishing the Post 1955 Retort Building. The debris placed within Monofill #2 consisted of retort building debris, bricks, and "slag"; tailings; and some arsenic-containing soil excavated

from the vicinity of the chemical storage sheds and mess hall/bunkhouse. The kiln bricks and slag were chemically encapsulated prior to disposal. The total volume of material in Monofill #2 is estimated at approximately 938 cubic yards. #2.

### 2004 AST/Ore Hopper Demolition and Petroleum Release Investigation. The BLM

demolished and disposed of five large ASTs and ore hopper in a third onsite monofill (Monofill #3). Environmental sampling, including 12 soil borings, was conducted to characterize the area near the Post-1955 Retort Building where they stood. Existing monitoring wells were sampled.

Soils data collected in the AST area indicated that petroleum hydrocarbons had been released to the environment and concentrations exceeded Alaska Department of Environmental Conservation (ADEC) cleanup standards.

Groundwater samples collected from the existing monitoring wells contained antimony, arsenic, and mercury at concentrations above ADEC cleanup standards. The groundwater samples contained detectable levels of diesel-range organics (DRO) and residual-range organics (RRO) in concentrations below ADEC cleanup standards.

### 2.4 Remedial Investigation

The BLM initiated a CERCLA RI in 2010 to characterize the nature and extent of remaining contamination and to develop a long-term remedy for the site. The RI involved extensive investigation of tailings/waste rock, native soils, surface water, groundwater, creek and river sediments, and vegetation. Data collected during the RI were used to define the site's physical setting, the nature and extent of contamination, and the fate and transport of contaminants. The RI included estimation of site-specific background values of inorganic analytes based on results of samples collected from background areas.

The RI results were used to assess risk to human health and the environment due to exposure to contaminated tailings/waste rock, soil, and Red Devil Creek sediments. Results of the Human Health Risk Assessment (HHRA) and Baseline Ecological Risk Assessment (BERA) were included in the 2016 RI Report. Baseline groundwater and surface water monitoring data collected in 2012 were appended to the RI Report.

A number of data gaps were identified through analysis of the initial RI data. Initial RI results did not fully address impacts to groundwater and the Kuskokwim River. A supplement to the RI was completed to address those data gaps associated and the results are documented in the 2019 RI Supplement. The results of the RI Supplement is discussed in Section 2.6.

#### 2.5 Feasibility Study

In 2016, the BLM completed a CERCLA FS at the site to analyze a variety of technologies to address contamination documented in the RI and assembled the technologies into four cleanup alternatives addressing tailings/waste rock and contaminated soil and Red Devil Creek sediment. Results were presented in the FS report in 2016 (E & E 2016). The FS did not address cleanup for groundwater or Kuskokwim River sediments because the need for, and extent of, cleanup of site groundwater and sediments in the Kuskokwim River had not yet been completely assessed. A supplement to the FS was completed to address data gaps associated with groundwater and

Kuskokwim River sediments. The FS Supplement is discussed in Section 2.8. The FS and FS Supplement collectively assembled the technologies and approaches into four sitewide cleanup alternatives.

### 2.6 Remedial Investigation Supplement

In 2018, the BLM completed an RI Supplement to address data gaps associated with soil, groundwater, and Kuskokwim River sediments that were identified as part of the development of sitewide remedial alternatives during the preparation of the FS. The RI Supplement also addressed changes in the groundwater and surface water monitoring network, and possible changes to groundwater and surface water conditions at the Red Devil Mine stemming from implementation of the non-time critical removal action performed by the BLM during the summer of 2014. In 2015, baseline monitoring was performed in conjunction with additional groundwater characterization conducted as part of the RI Supplement. The results were presented in the RI Supplement report in 2018.

In 2015, RI Supplement sediment characterization activities were performed to address data gaps associated with sediment in the Kuskokwim River near and downriver of Red Devil Creek. The RI Supplement sediment characterization was designed to assess the following:

- Cross-river and downriver extents of contamination in Kuskokwim River sediment;
- Turbidity of Kuskokwim River water;
- Toxicity of sediments to benthic macroinvertebrates; and
- Potential for methylation and bioaccumulation of mercury.

The Kuskokwim River sediment background values were updated in the RI Supplement report to include results of additional background sediment samples collected as part of the RI Supplement.

As part of the RI Supplement, an HHRA Supplement was performed to address data gaps associated with the Kuskokwim River sediments that were not addressed as part of the RI effort—specifically, to assess the risks and hazards from potential exposure to COPCs through direct contact and incidental ingestion of sediment, and consumption of fish from the Middle Kuskokwim River region. In addition, a BERA Supplement was performed to assess potential risks to aquatic-dependent receptors that use the Kuskokwim River near and downstream from the Red Devil Mine. The HHRA and BERA Supplement results were presented in the RI Supplement report in 2018.

### 2.7 Background Concentrations in Groundwater

Data collected during the RI, the RI Supplement, and later groundwater monitoring collectively provide a comprehensive assessment of the site contaminants of potential concern (COPCs), the extent of groundwater contamination, and how critical subsurface contaminant migration pathways. In 2019, the BLM completed additional characterization of bedrock, soil, tailings/waste rock, and groundwater. The additional groundwater characterization was performed to support a more detailed pre-design hydrogeologic analysis of a proposed on-site repository as well as support the development of a detection groundwater monitoring network for the proposed repository. The effort included preparation of a conceptual design and a refined contaminant fate and transport model for a proposed repository at the site. Results of the

additional groundwater characterization were integrated with the RI and RI Supplement groundwater characterization to develop a comprehensive characterization of groundwater depths, gradients and flow paths, groundwater quality, and factors and processes influencing groundwater and surface water quality, including naturally mineralized bedrock in addition to tailings/waste rock and contaminated soil. Results were synthesized in the Groundwater and Surface Water Report that was finalized in 2019.

Natural mineralization typically exerts significant influence on concentrations of the metals considered contaminants at mine sites. The BLM's initially estimated background concentrations in groundwater using two monitoring wells located outside and upgradient of the Main Process area where tailings are prevalent. However, these two wells are located outside of the zone of natural mineralization,. Working in coordination with the ADEC and EPA, the BLM located and installed additional monitoring wells that better represent background conditions at RDM. The background data collected from the additional wells were used to develop the groundwater remedial goals presented in the FS Supplement (see Section 2.8) and serve to define baseline conditions that will be used as a basis of comparison with data collected as part of long-term monitoring.

#### 2.8 Feasibility Study Supplement

In 2019, the BLM prepared an FS Supplement focused on groundwater and sediment in the Kuskokwim River. Combined results of the RI, RI Supplement, and additional characterization and baseline monitoring were used to support the development of the FS Supplement. The FS Supplement report contains analysis of a variety of technologies to address contaminated tailings/waste rock, soil, and Red Devil Creek sediments documented in the RI, and assembles the technologies into four cleanup alternatives.

In 2016, as part of the FS, the BLM prepared a hydrologic analysis of the cover system, contents and subsurface beneath repositories described as part of remedial alternative 3. The four variations of Remediation Alternative 3 different combinations of an impermeable geomembrane cover system for the repository and subsurface liner. An initial hydrologic analysis was performed in 2016 to evaluate the potential for infiltration and migration of leachate for a repository without a bottom liner. The hydrologic analysis was summarized in the *Hydrologic Analysis, Red Devil Mine Site Report*, (Appendix A of the 2016 FS report). Results indicated that concentrations of the primary COPCs in leachate would reach negligible levels at a depth in the unsaturated zone well above the water table.

The additional groundwater characterization described in Section 2.7 provided additional geologic and hydrogeologic data that allowed for more detailed analysis. The BLM performed a second hydrologic analysis of the cover system, contents and subsurface conditions for the repository proposed as part of Remediation Alternative 3. The additional data allowed the BLM to develop more refined assumptions and model input parameters more representative of site conditions. The results of the second analysis show that, for all COPCs, the concentrations in leachate decrease to levels below State of Alaska drinking water criteria at a depth of less than 4 feet below the base of the repository. The depth to groundwater in the area of the footprint of the refined conceptual repository varies laterally and temporally, ranging from approximately 25

to 45 feet. For the purposes of the model, a minimum distance of 10 feet between the bottom of the tailings/waste layer of the repository and the groundwater was assumed.

### 2.9 Non-Time Critical Removal Action

The BLM worked with the U.S. Army Corps of Engineers to implement a Non-Time Critical Removal Action (NTCRA) as an "early action" at the site in 2014. As outlined in the Engineering Evaluation/Cost Analysis (EE/CA) and Action Memo, the primary objective of the early action was to reduce the transport of contaminated tailings and waste rock from the site into the Kuskokwim River. To accomplish this goal, the early action involved re-grading tailings to reduce erosion in steeply sloped areas of the Main Processing Area, stabilizing the creek channel sidewalls with rock-filled baskets (gabions), and installing a sediment trap downstream of the realigned portion of the Red Devil Creek channel. This action was not intended to clean up the creek, but rather to construct structures that would prevent additional erosion and transport of tailings into the Kuskokwim River during the period before final action was taken. This work was completed in July 2014. The BLM's public involvement activities associated with the NTCRA are described in Section 3.

# **3.0 COMMUNITY PARTICIPATION**

Since 2010, the BLM has consulted regularly with interested Tribes and communities in the project area and used newsletters to keep residents informed of the progress of the RI/FS. BLM proactively coordinated with both Calista, the regional corporation, and TKC, the village corporation throughout the entire RI/FS process, beginning with briefing them on the project planning stages through the execution of the RI/FS and development of the Proposed Plan. The BLM conducted meetings at multiple communities to discuss the RI in the spring of 2010, 2011, and 2012.

In 2012, the BLM hosted an information exchange session during the Alaska Forum on the Environment. The BLM also held community meetings and one Tribal consultation in 2014 regarding the NTCRA (see Section 2.9) at the site to hear residents' comments, questions, and concerns.

The BLM held one community meeting in 2017 in Bethel and a series of community meetings in 2018. The 2018 meetings focused on remediation alternatives evaluated in the FS. In all, BLM hosted 35 community meetings and distributed 12 newsletters informing the public of the progress of the CERCLA process at the Red Devil Mine prior to distribution of the Proposed Plan. These newsletters can be accessed at <a href="https://www.blm.gov/programs/public-safety-and-fire/abandoned-mine-lands/regional-information/alaska/projects/red-devil-mine/community-involvement">https://www.blm.gov/programs/public-safety-and-fire/abandoned -mine-lands/regional-information/alaska/projects/red-devil-mine/community-involvement</a>

For all the meetings summarized above, BLM contacted 15 communities formally by letter and informally by telephone to schedule the meetings. BLM requested to be invited to each of the communities in the project area to present RI/FS information. BLM travelled to each of the communities along with representatives of ADEC, the Alaska Agency for Toxic Substances and Disease Registry, EPA, and DHSS.

Pursuant to its lead agency authority under CERCLA, the BLM issued a Proposed Plan for public review on February 4, 2020, identifying its Preferred Alternative to address the release and threatened release of hazardous substances at or from the site (E & E 2020). An advance copy of the Proposed Plan was shared with TKC in fall of 2019, specifically to solicit their comments before it was presented to the wider public. BLM also contacted Calista for the same opportunity, but they declined to review the advance copy of the plan. The Proposed Plan was placed in the administrative record and was distributed via certified mail on February 4, 2020, to three Tribes, local governments, and Alaska Native Corporations in the middle Kuskokwim River region. The Proposed Plan was also distributed to the EPA Region 10, ADEC, Alaska Department of Health and Human Services, and Alaska Department of Natural Resources (DNR). The BLM presented a summary of the RI/FS and described the preferred remediation alternative at the Alaska Forum on the Environment in February 2020.

Pursuant to NCP Section 300.430(f)(3)(i)(C), a 30-day public comment period on the Proposed Plan began on March 1, 2020. Ten public meetings were scheduled for March and April 2020. Those meetings were postponed on March 16 due to the onset of the COVID-19 pandemic. In a letter to the BLM on April 15, 2020, the Calista Corporation requested an extension of the comment period. The BLM extended the comment period for the Proposed Plan through

December 18, 2020. The public meetings originally scheduled for March and April were held virtually in October 2020.

On September 17, 2020, the BLM sent certified letters to 36 Tribes, local governments, and Alaska Native Corporations to notify them of the opportunity to participate in the virtual public meetings. The letters included the link to the BLM's Red Devil Mine web page, where participants could find links to the virtual public meetings, meeting presentations, Proposed Plan, and administrative record. Toll-free conference lines were established as an alternative for those with limited internet access to participate in the virtual meetings. The letter also invited communities to suggest additional meeting dates. In addition, postcards with the meeting dates and the link to the BLM's Red Devil Mine web page were mailed to the 316 recipients of the Red Devil Mine newsletter.

In early October, meeting flyers and hard copies of the presentations were sent to each of the 36 Tribes, local governments, and Alaska Native Corporations on the project distribution list. Because the village of Red Devil has limited internet access, hard copies of the Proposed Plan and the meeting presentations were mailed to each Red Devil post office box holder. In accordance with the NCP, the Notice of Availability of the administrative record was published on October 7, 14, and 21, 2020, in *The Delta Discovery*, a newspaper of general circulation printed and published weekly in Bethel, Alaska. The ads included the virtual meeting dates, times, and links as well as the BLM Red Devil Mine web page with the Proposed Plan, meeting presentations, and administrative record.

Virtual meetings were conducted on October 20, 22, 27, and 29, 2020, to present the Proposed Plan and solicit oral and written comments on the Proposed Plan from interested parties. Sixteen people attended the virtual public meetings, including four representatives of contracting or consulting firms and four representatives of the BLM. The BLM representatives explained the Preferred Alternative and other alternatives under consideration and answered questions from the public. A court reporter attended each of the virtual public meetings and prepared detailed meeting transcripts. The BLM considered and responded to all oral and written comments received on the Proposed Plan. The responses are included in the Responsiveness Summary in Part III of this document.

The administrative record for the Selected Remedy, which is located online at: <u>https://www.ak.blm.gov/red\_devil\_mine/Red\_Devil\_Mine\_Admin\_Record.html</u> and in hardcopy at the BLM's Public Room at 222 W 7<sup>th</sup> Avenue in Anchorage contains copies of the Proposed Plan, public meeting transcripts, public comments received regarding the Proposed Plan, and technical reports and other documents upon which the Record of Decision (ROD) is based, including the RI, FS, and supplemental studies.

# 4.0 SCOPE AND ROLE OF THE RESPONSE ACTION

The BLM is conducting CERCLA response actions at Red Devil Mine using a phased approach. The first phase included the 2014 NTCRA. The intent of that removal action was to stabilize ongoing erosion and migration of tailings into Red Devil Creek and the Kuskokwim River until sitewide remedial actions are implemented.

The Proposed Plan and this ROD address the remedial action phase of CERCLA response actions at the site. The intent of this phase is control and containment of the primary sources of contaminants at the site. The scope of the Selected Remedy for this phase includes the following elements:

- Excavating contaminated tailings/waste rock, soil, and sediments in Red Devil Creek at the site, including Monofill #2;
- Excavating nearshore sediments located downstream of the Red Devil Creek delta;
- Treatment using solidification of tailings/waste rock excavated from the Main Processing Area and Monofill #2 that fail the TCLP test for arsenic;
- Consolidating appropriate excavated materials into an engineered repository and disposing of materials not appropriate for the repository at an appropriate facility;
- Long-term maintenance of the engineered repository and monitoring downgradient groundwater;
- Capping exposed highly mineralized areas in the Surface Mined Area;
- Long-term monitoring of groundwater in the Red Devil Creek watershed;
- Monitoring of Kuskokwim River sediments to verify remedy effectiveness; and
- Installing exclusion fencing to protect wildlife and implementing restrictions on public access and future use of the site area.

# 5.0 SITE CHARACTERISTICS

This section summarizes information obtained through the RI/FS process. It includes a description of the conceptual site model upon which investigations, assessment of risks, and response actions are based. The following sections summarize the major characteristics of Red Devil Mine and the nature and extent of contaminant releases. More detailed information is contained in the RI/FS and supplemental reports, which are included in the administrative record.

### 5.1 Site Description

The Red Devil Mine is located in the valley formed by Red Devil Creek, a tributary of the Kuskokwim River. The site is accessed from the nearby village of Red Devil by an unpaved road. No buildings currently exist on site. The Red Devil Mine site encompasses the areal extent of contamination and all suitable areas in proximity to the contamination necessary for implementation of a response action. Historical mining operations left tailings and other remnants that have affected local soil, surface water, sediment, and groundwater. Key areas at the site are:

- The Main Processing Area.
- The lowest reach of Red Devil Creek, that runs through the Main Processing Area to the creek's delta at its confluence with the Kuskokwim River.
- The area west of the Main Processing Area where historical surface exploration and mining occurred, referred to as the Surface Mined Area. The Surface Mined Area is underlain by the area of underground mine workings. The "Dolly Sluice" and "Rice Sluice" and their respective deltas on the bank of the Kuskokwim River are associated with the Surface Mined Area.
- Sediments in the Kuskokwim River. The riverbed sediments are located within submerged lands of the Kuskokwim River owned by the State of Alaska and managed by the DNR.

#### 5.2 Waste Disposal Locations

The majority of the tailings and waste rock are situated in the approximately 12-acre Main Processing Area, located approximately 1,000 feet from the Kuskokwim River. Red Devil Creek flows through the middle of the Main Processing Area on its way to the Kuskokwim River (see Figure 1-2).

Tailings and waste rock extend from the Main Processing Area down the channel of Red Devil Creek and have formed a delta at the mouth of the creek on the shore of the Kuskokwim River. A total of 210,000 cubic yards of tailings, waste rock, and contaminated soil and Red Devil Creek sediment are estimated to be present at the site, predominantly in the Main Processing Area. It is likely that some of these tailings and waste rock are commingled with petroleum-related contaminants from the former fuel ASTs and associated pipelines. In addition, an unknown volume of contaminated native soils and creek sediment are present.

The Surface Mined Area is currently heavily vegetated, contains exposed ore-bearing bedrock, old mine shafts (now closed), and several areas where hydraulic sluicing was used to remove unconsolidated overburden to expose bedrock for surface exploration and mining. The waste material from the sluice operations was washed down a gully to the Kuskokwim River, resulting

in the formation of the Dolly Sluice Area delta on the Kuskokwim River. Surface mining also included trenching, bulldozing, and pit excavation. Soil sampling performed during the RI identified several areas where weathered, mineralized bedrock influences soil concentrations, but no evidence of processed tailings was found in the Surface Mine Area.

### 5.3 Geology, Hydrology, and Climate

The following sections briefly describe the geology, hydrology, and climate at the Red Devil Mine. More detailed descriptions are presented in the Groundwater and Surface Water Report that was finalized in 2019.

#### 5.3.1 Geology

The bedrock geology at the Red Devil Mine is dominated by the deformed Cretaceous sedimentary rocks of the Kuskokwim Group. The Kuskokwim Group in the area of the Red Devil Mine comprises a thick marine turbidite sequence consisting of interbedded graded graywacke (a type of sandstone), siltstone, and argillaceous rock (siltstone that has been metamorphosed by pressure and relatively low temperature). The graywacke beds range in thickness from half a foot to about 20 feet, and commonly are 2 to 3 feet thick. Discrete argillaceous beds are commonly a few inches thick, but locally they have a cumulative thickness of 20 or 30 feet. The Kuskokwim Group are intruded by hydrothermally altered dikes that range from 1 foot to about 14 feet in thickness. Dikes are magma that is injected into bedrock along existing fractures and then cool to form linear "sheets" of igneous rock with the greywacke. Hot water often accompanies the magma, and that water contains high concentrations of metals that, upon cooling, form mineral crystals in the interface between the igneous dikes and the bedrock. Three dikes located in the area of the Red Devil Mine played a key role in the development of the ore bodies targeted during mining.

The Red Devil Mine is located on the limb of a northwest-trending fold in the layered bedrock. The bedding (layers) of the Kuskokwim Group in the Red Devil Mine area strikes (align) generally northwest and dips toward the southwest. The bedrock is fractured by two sets of joints (fractures) that intersect each other and bedding. Joints are best developed in the more competent (harder and more brittle) graywacke beds. The joints formed at the time of folding, and the igneous dikes intruded into some of the joints.

No quaternary faults are mapped within approximately 46.5 miles of the Red Devil Mine (the Quaternary is recent time on the geologic time scale and in the case of Red Devil Mine, this means all faults and joints are relatively old, suggesting all the structures and mineralization are old). Older faults were mapped in detail during mine development. In general, the dominant faults at the mine strike northwestward, are commonly parallel to bedding, and are particularly well developed and numerous in the argillaceous rocks. No specific information regarding fracture apertures or sealing of the various faults is available. However, the localization of most of the bedding-plane faults in incompetent argillaceous rocks results in poor development of open fractures. Faulting occurred after the folding and formation of joints, and where faulting occurred along argillaceous beds, the faults offset the joints.

Native soils at the Red Devil Mine consist of loess, soils derived from weathering of local bedrock, and alluvial deposits associated with the Kuskokwim River and Red Devil Creek. In

upland areas near the Red Devil Mine, the bedrock is overlain by thin soils (colluvium) derived from weathered bedrock. The colluvium is overlain in places by deposits of loess (windblown silt). The loess deposits are buff colored and friable, range from a few inches to about 30 feet in thickness, and commonly lack bedding. Colluvium and loess materials are also present in the Red Devil Creek valley, along with alluvial deposits of Red Devil Creek. Near the Kuskokwim River, there are deposits of Kuskokwim River alluvium.

The bedrock at the Red Devil Mine is locally mineralized. Hydrothermal mineralization of the bedrock at the Red Devil Mine resulted in the ore zones targeted during mining as well as the associated sub-ore-grade mineralized zones peripheral to the ore deposits. The ore minerals are cinnabar (mercury sulfide) and stibnite (antimony sulfide). Other sulfide minerals locally present in the mineralized zones are realgar and orpiment (arsenic sulfides) and pyrite (iron sulfide). The hydrothermal solutions responsible for deposition of the minerals were derived from dehydration of hydrous minerals in the argillite/shale and mobilization of waters of the Kuskokwim Group host rock by heat from igneous plutons that locally intruded the host rock. The hydrothermal solutions migrated through permeable rocks and along fractures and faults until the ore minerals, other sulfides, and other gangue minerals (e.g., quartz, carbonate, and clay) precipitated out of solution. The geometry of the ore body is strongly controlled by bedrock structure. The richest ore occurs in numerous discrete elongate bodies (ore shoots) that are mainly localized along and near linear intersections of dikes and faults associated with the Red Devil Fault that cut the dikes into segments. At a minimum, the extent of ore-grade mercury mineralization would be defined by the extent of mining. However, high concentrations of cinnabar that were not economically recoverable likely are present beyond the extent of mining. Similarly, high concentrations of other sulfide minerals as well as elevated concentrations of mercury, antimony, and arsenic in non-sulfide forms, are present in the mineralized zone beyond the extent of mining.

The geological features described above have been modified by mining and cleanup activities as well as natural processes like erosion and deposition. Non-native materials at the site consist of various types of mining and ore processing wastes and fill. Mining-related waste consists of waste rock, dozed and sluiced overburden, flotation tailings, and tailings (thermally processed ore, also known as calcines, burnt ore, and retorted ore). Tailings and waste rock were typically mixed at the Red Devil Mine and referred to as tailings/waste in site documents. Native materials have been removed, disturbed, relocated, covered, and/or mixed with other native soils and/or mine waste and tailings and fill locally across the site. Some of the native soils are naturally mineralized. During the RI, RI Supplement, and additional soil characterization activities, multiple lines of evidence were used to identify the various mine wastes and soil types and to define their distribution. The distribution of these materials, along with the characteristics of the natural environment, play a role in the nature and extent and fate and transport of contamination at the Red Devil Mine.

#### 5.3.2 Groundwater

Groundwater occurs at the Red Devil Mine in a bedrock aquifer and unconsolidated materials consisting of tailings/waste rock and native soils. Groundwater within the Kuskokwim Group bedrock appears to occur primarily within fractures. Unconsolidated overburden and bedrock saturated zones appear to be in hydraulic communication on a large scale at the Red Devil Mine,

although some hydrologic segregation exists locally, particularly at the top of weathered bedrock in parts of the site. Groundwater also occurs in underground mine workings within the bedrock. Groundwater at the Red Devil Mine was characterized as part of the RI, RI Supplement, and additional characterization and baseline monitoring activities. Baseline groundwater monitoring has been performed to characterize pre-remedial action conditions and identify seasonal and annual trends in flow, contaminant concentrations, and loading.

The depth to groundwater varies laterally and temporally, with the highest water levels occurring in the spring. Within the Main Processing Area and particularly adjacent to Red Devil Creek, the water table occurs within the unconsolidated materials at depths ranging from 0 feet (along Red Devil Creek) to more than 30 feet. In the Surface Mined Area, the water table occurs within bedrock at depths typically greater than 20 feet and ranging up to more than 130 feet near the underground mine workings.

Groundwater throughout most of the site generally flows toward Red Devil Creek. Overall, the groundwater and surface water at the site is that of a fractured bedrock and alluvial aquifer in a small watershed anchored by a predominantly gaining stream. A notable exception is the portion of the Surface Mined Area where the system of underground mine workings exerts a draining effect and a highly transmissive hydraulic connection between much of the Surface Mined Area and the Red Devil Creek valley (the collapsed underground workings transmit groundwater much more efficiently than the surrounding bedrock, creating a steep trough in the water table that aligns with the workings).

#### 5.3.3 Red Devil Creek

Red Devil Creek is a relatively small tributary of the Kuskokwim River. The creek drains a total area of approximately 1.08 square miles, 85 percent of which lies upstream of the Red Devil Mine. The reach of the creek affected by the mine, extending to the delta in the Kuskokwim River is approximately 2,500 linear feet. Flow in Red Devil Creek measured at the Red Devil Mine ranges from less than 1 cubic foot per second (cfs) to more than 16 cfs, depending on season and location. Red Devil Creek has an average gradient of approximately 5 percent between the location where the reservoir dam once stood and the Kuskokwim River. On a sitewide scale, Red Devil Creek exhibits predominately gaining conditions. Groundwater emerges to surface water as Red Devil Creek baseflow and via the seep located adjacent to the creek in the Main Processing Area. While it is classified by the Alaska Department of Fish and Game as an anadromous fish stream, Red Devil Creek does not support permanent populations of game or subsistence fish.

Mining and ore processing activities were conducted in the Red Devil Creek valley. Tailings and waste rock were disposed of within the Red Devil Creek valley. These materials, mixed with alluvium, extend from the Main Processing Area down the channel of Red Devil Creek to the delta at the mouth of the creek on the shore of the Kuskokwim River. A barge landing was constructed at the delta of Red Devil Creek when the mine was developed. The creek channel has evidently migrated over time due to emplacement of mine waste materials into the streambed in the Main Processing Area and other modifications. The channel has likely also migrated as a result of heavy sediment loading downstream. Impacts of mining activities on Red Devil Creek are summarized in Section 5.4.

#### 5.3.4 Kuskokwim River

The Kuskokwim River drains an area of approximately 50,180 square miles and flows approximately 700 miles from interior Alaska to the Bering Sea. At the Red Devil Mine, the Kuskokwim River is more channelized than in upriver locations where it bisects the Kuskokwim Mountains. The Red Devil Mine is situated on a cut bank of the river. Flow in the river near the Red Devil Mine has been reported at rates greater than 100,000 cfs, with average mid-summer flows ranging from 50,000 to 60,000 cfs. The Kuskokwim River is generally ice-free from mid-June through October.

#### 5.3.5 Climate and Weather

The Red Devil Mine 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 degrees Fahrenheit. Annual snowfall averages 56 inches, with a total mean annual precipitation of 18.8 inches. The site's subarctic climate was considered in the technical evaluation of the remediation alternatives. Potential effects of climate change were also considered in the evaluation of the alternatives.

#### 5.4 Summary of the Nature and Extent of Contamination

The nature and extent of contamination at the Red Devil Mine was investigated during the RI and RI Supplement. Site-specific background values of inorganic analytes were estimated based on sample results from background areas. Analytical results for samples collected throughout the site were used to define the lateral and vertical extent of contamination in soil, groundwater, surface water, sediment, and vegetation. Inorganic element concentrations that exceed background values are considered "contamination". For organic analytes, all positive detections that were found in soil and groundwater near the former AST area were considered to represent site-related contamination. The term "contamination" in this ROD refers to the non-natural presence of elevated chemical concentrations in media and is different than the contaminants of concern (COCs) (see Section 8.3) that are identified based on a combination of risk- and regulatory-based criteria.

As part of the RI, characterization of areas considered to be background was performed to estimate background values of inorganic elements in surface soil, subsurface soil, groundwater, Red Devil Creek surface water and sediment, Kuskokwim River sediment, and vegetation. Many of the same inorganic elements that comprise contamination—notably including antimony, arsenic, and mercury, the primary COPCs—also occur naturally in native bedrock, soil, sediment, and groundwater and surface water that flow through them. Such naturally occurring concentrations represent pre-mining "background" conditions. Samples used for background value estimation were collected from locations outside of and upgradient of the areas recognized as potentially impacted by mining, ore processing, waste disposal operations, and potential deposition of emissions from thermal ore processing. The selected background areas for all media except Kuskokwim River sediment are located within the upland area west of the Surface Mined Area and the Red Devil Creek valley southwest of the Main Processing Area. Background samples for Kuskokwim River sediment were collected from locations upriver of the site based on samples collected as part of the RI and additional samples collected as part of the RI Supplement. Background values were estimated using statistical methods following EPA

guidance. The results of the RI background evaluation for surface soil, subsurface soil, and Red Devil Creek sediment and surface water are presented in Table 5-1.

The Kuskokwim River sediment background values were updated in the RI Supplement report to include results of additional background sediment samples collected as part of the RI Supplement. The resulting revised background values for Kuskokwim River sediment are presented in Table 5-1.

As part of the RI, background groundwater values were proposed based on results of samples collected from two wells-MW12, screened in alluvium located within the Red Devil Creek upstream alluvial area, and MW31, screened in bedrock within the upland area west of the Surface Mined Area. These wells were originally proposed for background groundwater characterization based on their locations outside and upgradient of any likely mining-related influence on groundwater COC concentrations. However, these wells also are located outside of the area of any natural mineralization in bedrock. Results of the RI Supplement and additional groundwater characterization improved the understanding of the impacts of natural mineralization in bedrock in the Surface Mined Area on groundwater quality. Results of the evaluation of these impacts were used to support development of estimates of groundwater quality for groundwater flowing through bedrock into the Main Processing Area. These estimates of groundwater quality were used to develop refined estimates of background groundwater values, as presented in Section 3.7 of the Groundwater and Surface Water Report. The resulting refined background values for groundwater are presented in Table 5-1. It should be noted that the groundwater sample results for bedrock wells in the Surface Mined Area vary widely between individual wells. As such, results from any given well are not representative of groundwater background levels throughout the watershed. The large variability in groundwater concentrations within the Surface Mined Area is significant for two reasons. First, the background concentrations estimated during the RI using data from wells MW12 and MW31 do not reliably predict what the COC concentrations in background groundwater would be prior to excavation and subsequent re-establishment of equilibrium groundwater conditions. Second, the variability is too great for a single value to represent baseline groundwater conditions within the Surface Mined Area. The refined background values presented in Table 5-1 were used as remedial goals to satisfy requirements for the FS Supplement. Alternative methods of establishing baseline groundwater concentrations will be explored at a later phase.

Concentrations of COPCs (note that units vary by COPC)				
Media	Antimony	Arsenic	Mercury	
Surface Soil (mg/kg)	8	28.58	1.86	
Subsurface Soil (mg/kg)	52.2	12.8	3.92	
Red Devil Creek Sediment (mg/kg)	0.54	65	0.18	
Groundwater – Total (µg/L)	12.99	444.1	1.628	
Surface Water – Total (µg/L)	1.52	1.1	0.00263	
Surface Water – Dissolved (µg/L)	1.4	0.9	0.00637	
Kuskokwim River Sediment (mg/kg)	0.583	13.4	0.141	

## Table 5-1 Background Values of Chemicals of Potential Concern at Red Devil Mine

Note:

Background values for surface soil, subsurface soil, Red Devil Creek surface water, and Red Devil Creek sediment are based on results presented in the RI Report. Background values for Kuskokwim River sediment are based on results presented in the RI Supplement Report. Background values for groundwater were developed to satisfy the requirements for the FS Supplement and are based on results presented in the Groundwater and Surface Water report.

#### Key:

COPC = chemicals of potential concern

mg/kg = milligrams per kilogram

 $\mu g/L = micrograms \ per \ liter$ 

The nature and extent of contamination is summarized in Sections 5.4.1 to 5.4.7. The nature and extent of contamination is summarized for the following geographic areas at the site:

- Main Processing Area.
- Red Devil Creek valley downstream of the Main Processing Area.
- Surface Mined Area, including the "Dolly Sluice" and "Rice Sluice" and their respective deltas on the bank of the Kuskokwim River.
- Kuskokwim River.

#### 5.4.1 Surface Soil

Thirteen inorganic elements were detected above background values in the surface soil samples from 0 to 6 inches. In addition, semi-volatile organic compounds (SVOCs), DROs, RROs, and polychlorinated biphenyl (PCBs) were detected in surface soil samples.

Inorganic elements were detected above background values in all general geographic areas. Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. The highest concentrations of these inorganic elements were in the tailings/waste rock in the Main Processing Area. These inorganic elements were also detected at concentrations well above background values in the Surface Mined Area. Analytical data collected through extensive surface soil sampling and visual observations during the RI demonstrated that process tailings are not present in the Surface Mined Area. Consequently, the elevated concentrations are not attributable to the presence of tailings/waste rock,but are present as a result of exposed naturally mineralized bedrock and associated soils.

Organic compounds were detected in the Main Processing Area. The areas of organic compound detections do not form contiguous zones, suggesting that releases from above ground tanks used

to store diesel fuel when the mine was operational. The organic compounds were detected near Red Devil Creek, downslope of the fuel storage tanks and associated pipelines.

#### 5.4.2 Subsurface Soil

Seventeen inorganic elements were detected above background values in the subsurface soil samples at depths greater than 2 feet. In addition, SVOCs, DRO, and RRO were detected in subsurface soil samples.

Inorganic elements were detected above background values in all general geographic areas of the site. Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. The highest concentrations of these inorganic elements were in the tailings and tailings/waste rock in the Main Processing Area. These inorganic elements were also detected at concentrations well above background values in subsurface soil in parts of the Surface Mined Area. Detailed observations of drill cuttings made at numerous soil boring and monitoring well locations in the Surface Mined Area support the conclusion that elevated concentrations in the bedrock are not attributable to the presence of tailings/waste rock but are present as a result of naturally mineralized bedrock and associated soils.

Organic compounds were detected in the Main Processing Area at depths up to 30 feet BGS. The extent of organic compounds in subsurface soil appears to be localized in areas associated with former fuel storage or distribution.

#### 5.4.3 Groundwater

Seventeen inorganic elements and methylmercury were detected above the RI background values in groundwater samples. Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above the RI background values. Groundwater is contaminated by inorganic elements leaching from mine wastes, including tailings/waste rock, flotation tailings, and contaminated soil. The greatest contamination impacts occur where tailings/waste rock materials within the Main Processing Area are within the saturated zone at least part of the time.

Groundwater is locally affected by inorganic elements present in naturally mineralized bedrock and native soils. Bedrock is naturally mineralized throughout portions of the Surface Mined Area and Main Processing Area, including zones that are peripheral to the mine workings. Groundwater in much of the Surface Mined Area flows through these mineralized zones within the host bedrock, increasing COC concentrations. As the groundwater flows downgradient into the Main Processing Area, COC concentrations are further increased due to leaching of the tailings/waste rock. Much of the groundwater discharges into Red Devil Creek. The RI Supplement and additional groundwater characterization addressed groundwater flow and the influence of natural mineralization and tailings/waste rock on COC concentrations in groundwater and surface water in the Red Devil Creek watershed. Results are synthesized in the Groundwater and Surface Water Report and FS Supplement Report. Impacts on groundwater quality from natural mineralization are significantly less than the impacts from leaching of the tailings/waste rock. As discussed above, results of the RI Supplement and additional groundwater characterization improved the understanding of the impacts of natural

mineralization in bedrock in the Surface Mined Area on groundwater quality and were used to refine the estimates of background groundwater values for the purpose of developing remedial goals to satisfy requirements for the FS Supplement. The resulting refined background values for groundwater are presented in Table 5-1.

Organic compounds were detected in groundwater from several wells screened in the unconsolidated materials in the Main Processing Area. None of the organic compounds detected exceeded comparison criteria in any of the groundwater samples. DRO was detected in groundwater samples collected from selected wells positioned downgradient of the AST area, but the concentrations were below ADEC groundwater cleanup levels. SVOCs and RRO also were detected in one or more samples below comparison criteria. In 2012, groundwater samples were collected from two wells for PCB analysis to assess possible impacts of PCBs associated with Monofill #1 since it contains empty transformers from the facility. PCBs were not detected in either sample.

### 5.4.4 Red Devil Creek Surface Water

Fifteen inorganic elements and methylmercury were detected above background values in the surface water samples collected from Red Devil Creek and the seep on the left bank of the creek in the Main Processing Area. In addition, several SVOCs were detected in several surface water samples.

Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. Starting at the upper end of the Main Processing Area, total and dissolved concentrations of antimony, arsenic, and mercury were significantly elevated above background values down to the mouth of Red Devil Creek. The highest arsenic concentrations were detected in the seep samples. Methylmercury was detected at all sample stations on Red Devil Creek (including near the reservoir dam) and is significantly elevated above the background value in the Main Processing Area, particularly at the seep location; however, methylmercury concentrations are below comparison criteria. All SVOCs in Red Devil Creek surface water were detected at low concentrations very near their respective method detection limits and below applicable regulatory comparison criteria (Alaska Water Quality Standards).

Groundwater that is impacted by flow through both tailings/waste rock and naturally mineralized bedrock emerges into Red Devil Creek as baseflow and via a seep in the Main Processing Area.

#### 5.4.5 Red Devil Creek Sediment

Sixteen inorganic elements and methylmercury were detected above background values in the Red Devil Creek sediment samples, which were collected at locations upstream of the Main Processing Area down to the mouth of the creek at the Kuskokwim River. In addition, SVOCs were detected at low concentrations in several sediment samples.

Of the inorganic elements detected, antimony, arsenic, and mercury concentrations were the most highly elevated above background values. These three inorganic elements are significantly elevated above background values in the creek section extending from the Main Processing Area to the mouth of Red Devil Creek. Methylmercury was detected above the background value in all

but one of the Red Devil Creek sediment samples – the highest concentrations were detected at the seep in the Main Processing Area upsteam of the mine near the location previously occupied by a dam and reservoir. The dam has been removed and the reservoir drained. All of the SVOCs in Red Devil Creek sediments were detected at concentrations near their respective method detection limits and below applicable comparison criteria.

#### 5.4.6 Kuskokwim River Surface Water

No sampling of Kuskokwim River surface water was performed. However, COC loading from Red Devil Mine via surface water and groundwater flow was evaluated and presented in the RI Supplement Report and Groundwater and Surface Water Report, respectively. Based on Red Devil Creek surface water quality data combined with discharge data for Red Devil Creek and the Kuskokwim River, the contribution of COC loading from Red Devil Creek to COC concentrations in the Kuskokwim River would be indiscernible. Similarly, based on estimated groundwater discharge and COC concentrations, combined with Kuskokwim River discharge data, COC loading to the Kuskokwim River via groundwater flux also would be indiscernible.

#### 5.4.7 Kuskokwim River Sediment

Seventeen inorganic elements and methylmercury were detected above background values in the Kuskokwim River sediment samples. River sediment samples were collected near the riverbank and in offshore locations immediately upstream and downstream of the mouth of Red Devil Creek, and spanning locations up to approximately 4 river miles downstream of the site. Concentrations of antimony, arsenic, and mercury generally decrease with distance downriver from the Red Devil Creek delta area. Concentrations generally decrease to values near background values approximately 0.62 mile downriver from the Red Devil Creek delta, coinciding with the mouth of McCally Creek in the river. Slight increases in concentrations at that location, and another increase in concentrations approximately two and a half miles downriver from the Red Devil Creek delta, likely reflect input from other documented mineral occurrences at those locations.

# 6.0 CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

This section summarizes the current and potential future land and resource uses of the Red Devil Mine site.

### 6.1 Current Land Use and Surrounding Area Population

The village of Red Devil is approximately 2 miles northwest of the site, and the village of Sleetmute is approximately 8 miles southeast of the site on the opposite side of the Kuskokwim River. The Kuskokwim River is used for transportation for both communities; boats are used in the summer and snow machines in the winter. The river is generally ice-free from mid-June through October. Both communities have gravel airstrips that planes can use year-round.

As of 2013, the village of Red Devil had a population of 18 persons. Its population was 43.5 percent American Indian or Alaska Native, 17.4 percent white, and 39.1 percent with multi-racial backgrounds. Sleetmute is a larger village than Red Devil and is an Ingalik Indian village, with a population of 97 persons in 2013. Approximately 77 percent of the population identifies as Alaskan Native. One school serves all students in the community (E & E 2014).

The site is not officially designated or used for Kuskokwim River access, residential, or recreational purposes and is surrounded by undeveloped public lands. Signs warning of the presence of environmental contaminants were posted by the BLM in 2012. BLM personnel observed indications of trespassing on site. It is believed that area residents may access the site for off-highway vehicle riding and/or hunting purposes. A gate was installed on the road to the mine entrance and evidence of trespassing has significantly diminished. The current primary human use of the site is for periodic sampling and monitoring of the groundwater well network as part of continuing site characterization efforts.

### 6.2 Anticipated Future Land Use

It is difficult to anticipate future land use of the site because there are uncertainties associated with its long-term ownership status. The lands that include the property of the Red Devil Mine are selected under the Alaska Native Claims Settlement Act (ANCSA) and under the Alaska Statehood Act as amended by the Alaska National Interest Lands Conservation Act (ANILCA). In both instances, BLM is the interim manager. The three following stakeholders each has a land title claim to the land and a stakeholder interest in future land use:

- The Kuskokwim Corporation (TKC) (representing a merger of 10 ANCSA Native village corporations);
- The Calista Regional Corporation; and
- The State of Alaska.

The State of Alaska is included in the list above because they have "top filed" the land pursuant to Section 906(e) of ANILCA.

The site is located in the township occupied by the Native village of Sleetmute. TKC represents the merger and consortium of 10 village corporations including Sleetmute, and TKC is authorized to represent the village corporations on ANCSA surface estate land issues. Under Section 14(h) of ANCSA, TKC is required to select all land in the township occupied by each of

their constituent communities. TKC's selection would, upon transfer, entitle them to the surface estate. The regional corporation, Calista, would accrue the subsurface interest pursuant to Section 14(f) of ANCSA to the Sleetmute lands. Such a split estate would apply to the land occupied by the Red Devil Mine at the time of conveyance. Calista has also selected the land in its own right under the regional entitlement of Section 14(h)(8) of ANCSA.

As long as the site is owned by the United States, it will be managed by the BLM and subject to the Bering Sea – Western Interior (BSWI) Resource Management Plan (RMP), or successor plan. The site is subject to the management decisions in the BSWI RMP and does not have any special designations. If the site is conveyed to TKC or Calista it would be subject to the Unorganized Borough's land use code. The site is located within the boundaries of the Unorganized Borough's general zoning district, which allows for any uses not prohibited by law or regulation (11 Alaska Administrative Code [AAC] 91.120).

It is expected that the site will continue to be managed as it is currently—primarily for cleanup activities—for the foreseeable future because the possible applicable land use regimes do not prescribe any particular use of the site. Furthermore, the possible private land owners, TKC and Calista, have not indicated what they might do with the site if they acquire it. In Performing the risk assessment set forth below, BLM assumed that the site's future land use is consistent with current land use in the vicinity of the site, such as residential, recreational, and subsistence uses. BLM assumed these future uses for the purposes of its risk assessment analysis.

#### 6.3 Surface Water and Groundwater Uses

There is one private drinking water well within a 1-mile radius of the site; it is located at a cabin near the mouth of McCally Creek, approximately 0.6 miles from the mouth of Red Devil Creek. Construction details of this well are unknown. Nineteen private drinking water wells were installed in the village of Red Devil in 2004 by the Alaska Village Safe Water Program. These wells range in depth from 28 to 172 feet BGS. It is unlikely that contaminants from the Red Devil Mine site would impact these drinking water wells, based on distance from the site and predominant groundwater flow at the site toward the Kuskokwim River. Surface water is not used for drinking purposes in the site area, although the Kuskokwim River supports an important subsistence and game fishery.

#### 6.4 Subsistence

The village of Red Devil is located approximately 2 miles northwest of the Red Devil Mine, and the village of Sleetmute is located approximately 8 miles southeast of the mine. Subsistence activities are practiced by members of both communities. During their respective season, salmon, bear, moose, caribou, rabbit, terrestrial birds, and waterfowl are caught and wild berries are harvested. The Kuskokwim River is used for transportation for both communities; boats are used in the summer and snow machines in the winter.

## 7.0 SUMMARY OF RISKS

The baseline risk assessment estimates what risks exist to human and ecological receptors exposed to hazardous substances released at or from Red Devil Mine if no action is taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action to eliminate unacceptable risks. This section of the ROD summarizes the results of the baseline risk assessment for the site.

#### 7.1 Overview of Risk Assessment Process

As part of RI/FS, the BLM completed assessments of human health and ecological risk based on the levels of contamination at the Red Devil Mine. HHRAs and BERAs estimate the health risks to people and the environment, respectively, from exposure to contaminants either now or in the future. "Risk" is the possible harm to people or wildlife from exposure to chemicals. Two types of health risks for people are evaluated: the risks that can cause cancer and the risks that can cause other health effects. Consistent with EPA guidance, the BLM evaluates only noncancer risks to wildlife. The HHRA and BERA were performed to evaluate potential risk posed by contamination of surface soil, subsurface soil, nearshore sediment, groundwater, surface water, and biota based on RI site characterization.

The initial RI and associated HHRA and BERA did not fully evaluate possible site impacts to the Kuskokwim River. Therefore, RI, HHRA, and BERA supplements were completed to address the Kuskokwim River.

All HHRA and BERA activities were conducted in accordance with EPA and Alaska State guidance. Methods and results of the initial HHRA and BERA are detailed in Chapter 6 of the RI Report, and methods and results of the HHRA and BERA supplements are detailed in Chapters 6 and 7 of the RI Supplement Report. The reports are included in the administrative record for Red Devil Mine. Findings of the HHRA and BERA and supplements are summarized below.

#### 7.2 Human Health Risk Assessment

For the HHRA, the main steps taken are identification of COPCs, exposure assessment, toxicity assessment, risk characterization, and uncertainty analysis, as summarized below.

#### 7.2.1 Selection of Contaminants of Potential Concern

Data gathered as part of the RI were used to identify and characterize a wide range of metals and organic compounds. Per the EPA's *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A)* (EPA 1989), soil, sediment, groundwater, and surface water concentrations are initially compared to risk-based screening concentrations (RBSCs) to eliminate from further consideration those analytes that represent a small contribution to overall risk. An analyte with a maximum concentration exceeding a screening value is considered a COPC and is evaluated quantitatively. Any analyte with a maximum concentration below a screening value is eliminated from consideration.

Several metrics are used for screening and selection of COPCs, including:

• Health-based screening values based on toxicological characteristics of each chemical; and

• Evaluation of essential nutrients.

Soil RBSCs include EPA Regional Screening Levels (RSLs) for residential soils (EPA 2012) adjusted to a cancer risk of 10<sup>-6</sup> or a hazard quotient (HQ) equal to 0.1, one-tenth of the human health exposure pathway cleanup levels (direct contact and inhalation) for the Under 40 inch zone (18 AAC 75.341, Table B1; and values provided in Appendix B of the Cumulative Risk Guidance [ADEC 2018]). There are no 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. Red Devil Creek sediments, as well as both nearshore and offshore Kuskokwim River sediment samples, were screened against these RBSCs to ensure that all COPCs were identified, although human receptors have no direct exposure to offshore Kuskokwim River sediments. Groundwater RBSCs include one-tenth Alaska groundwater cleanup levels (18 AAC 75.345, Table C), EPA RSLs (EPA 2012) for tap water adjusted to a cancer risk of 10<sup>-6</sup> or an HQ equal to 0.1, and federal maximum contaminant levels (MCLs). COPCs exceeding any of the applicable screening criteria were included in the assessment for quantitative determination of risk. As a health-protective measure, groundwater RBSCs were applied to surface water to determine surface water COPCs.

Based on RI characterization results, a number of inorganic compounds were detected in background samples as well as site samples at levels above RBSCs. Consistent with the EPA's policy, no COPC was eliminated based on comparison to background values. However, background values were used to assess the contribution from elevated background values to overall risks and hazards at the site. Evaluation of background values is summarized in Section 5.4.

The EPA recommends (EPA 1989) removing chemicals from further consideration if they are considered "essential nutrients." The essential nutrients that were eliminated from the list of COPCs are magnesium, calcium, sodium, and potassium.

#### 7.2.2 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 Red Devil Mine. The exposure assessment characterizes the exposure setting; identifies receptors that may be exposed; identifies direct and indirect pathways by which exposures could occur (e.g., 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.

To assess the potential risks to human health associated with COCs, the HHRA estimated potential risks to various potential human receptors under several exposure scenarios, based on land use in the vicinity of the Red Devil Mine site. The receptors evaluated include typical receptor classes in CERCLA risk assessments intended to reflect conservative assumptions about future use/occupancy of the site. They include:

- Hypothetical future residents (both adult and child);
- Current/future recreational or subsistence users (both adult and child) that could visit the site; and
• Future mine workers (adult).

The following exposure scenarios were quantitatively evaluated in the HHRA for the various receptors:

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

It was assumed that all potential human receptors participate in some form of subsistence activity, including fishing, hunting, and gathering wild foods near the Red Devil Mine site. It was assumed that potential users of the site would come in contact with surface water from Red Devil Creek, sediments from Red Devil Creek and the Kuskokwim River, and soil from around the site. It was also expected they would eat wild foods and breathe air potentially impacted from volatile compounds. Although groundwater is not currently used at the site, it was assumed that if residents or mine workers used the site in the future, they could use the groundwater for drinking. Currently, no one lives at the Red Devil Mine site, so some assumptions were made about where people might put residences in the future. Potential risks were estimated for the Main Processing Area, Surface Mined Area, and Red Devil Creek downstream alluvial area.

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 health-protective exposure scenario that is plausible, yet well above the average exposure level. In addition to intake rates, exposure factors for body weight, exposure frequency, exposure duration, and averaging time are included in the evaluation of intake. To develop the appropriate wild food (vegetation and animals, including fish) intake rates for use in the HHRA, the BLM coordinated with representatives from the EPA, ADEC, Alaska Department of Health and Social Services, and the Agency for Toxic Substances and Disease Registry to develop consumption estimates.

Using total soil arsenic concentrations to quantify daily chemical intake typically results in overestimates of the cancer risk posed by arsenic. Based on EPA and ADEC input, and consistent with EPA recommendations on assessing bioavailability of arsenic in soil, soil intakes were multiplied by an estimated relative bioavailability value of 60 percent, to quantify the level of arsenic that reaches systemic circulation for soil ingestion and dust inhalation of arsenic.

Concentrations of COPCs which human receptors would potentially be exposed to over time, or exposure point concentrations (EPCs), were estimated for all affected media.

Groundwater EPCs were based on maximum concentrations. Soil, sediment, and surface water EPCs were estimated using the 95-percent upper confidence limit of the mean concentration (UCL), which is consistent with EPA and ADEC guidance. Inherent in this approach is the assumption that receptors that contact an environmental medium containing a COPC randomly. Thus, an estimate of average concentration (or the upper bound of the average, when the 95 percent UCL is used) is the concentration to which a receptor might be exposed.

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. Estimated media concentrations are used for exposure pathway calculations and estimating COPC concentrations in wild food.

Concentrations of COCs in game fish were estimated using a health-protective food chain multiplier (FCM) approach. The BLM conducted a 3-year study of resident fish in the Kuskokwim River and numerous tributaries including Red Devil Creek. A number of different fish species were collected and analyzed for metals and organic compounds.

Sculpin are a small species of fish with a very narrow range of movement that were collected from Red Devil Creek as part of the wider fish tissue study. Whole sculpin samples were analyzed for the same chemical constituents as fish collected from the Kuskokwim River and other tributaries. The resulting sculpin tissue data from Red Devil Creek were used to estimate concentrations of COCs in game fish consumed by receptors. For methylmercury, an FCM of three was assumed to account for biomagnification. In other words, the concentration of methylmercury in game fish was set equal to three times the concentration in sculpin. For inorganic mercury and other metals, an FCM of one was assumed. It was assumed that the game fish of interest—Dolly Varden (Salvelinus malma), sheefish (inconnu), round whitefish (Prosopium cylindraceum), whitefish (other; Coregonus lavaretus), burbot (Lota lota), grayling (Thymallus thymallus), and northern pike (Esox Lucius)-are one trophic level above the sculpin, except for grayling, which feed at a slightly lower trophic level than sculpin. This is a healthprotective assumption. Because sculpin are more resident than the fish taken from the Kuskokwim River, using the Red Devil Creek sculpin data to estimate game fish concentrations in the Kuskokwim River likely overestimates the true concentrations of fish that people catch and consume from the Kuskokwim River.

#### 7.2.3 Toxicity Assessment

The toxicity assessment compiles information on adverse health effects associated with COPC exposure and provides an estimate of the dose-response relationship for each COPC (i.e., estimate the relationship between the extent of exposure and increased likelihood and/or severity of adverse effects). COPCs are divided into two groups: agents known or suspected to be human carcinogens (carcinogens) and noncarcinogens. The dose-response relationship provides the basis for development of toxicity values used in the risk assessment. Toxicity values were chosen according to the following hierarchy recommended in EPA and ADEC guidance.

#### 7.2.4 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. The parameter values and risk assessment methods applied in the HHRA relied on multiple conservative assumptions that are designed to ensure the likelihood that potential exposures and risks to receptors were not underestimated. For carcinogens, the estimated excess lifetime cancer risk values are summarized in Table 7-1 and for noncarcinogens, the estimated hazard indices (HIs) are summarized in Table 7-2.

Based on results of the HHRA, COCs were identified. The COCs consist of 10 inorganic elements—antimony, arsenic, barium, chromium, copper, lead, manganese, mercury, nickel, and selenium—and two organic compounds, methylmercury and petroleum hydrocarbons. Of the 10 inorganic COCs, antimony, arsenic, and mercury drive the majority of the cancer risk/toxic hazard documented in the risk assessment and are therefore the most important for risk management. For each COC, potential risk-based concentration levels (RBCLs) were developed for the primary COCs—arsenic, antimony, and mercury—and other COCs in soil, groundwater, and biota.

#### 7.2.5 Uncertainty Analysis

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. Uncertainty is inherent in every step of the risk assessment process. The HHRA included an analysis of uncertainties associated with each step of the process and the ways they are likely to affect the overall risk estimates. The HHRA included several areas of uncertainty, including the following sources of significant uncertainty:

- Modeled concentrations of COCs in some wild food, specifically game fish;
- Estimated consumption of wild food and assuming that residents harvest and consume wild food from the site; and
- Characterization of true background values in the mineralized area.

Medium	Exposure Route	Future Resident - Surface Mined Area	Future Resident - Main Processing Area	Future Resident - RDC Downstream Alluvial Area	Recreational/ Subsistence User	Mine Worker
	Ingestion	8E-03	1E-02	5E-03	3E-03	2E-03
Soil	Dermal	1E-03	2E-03	8E-04	5E-04	5E-04
Sediment	Dermal	5E-03	5E-03	5E-03	5E-03	2E-03
	Ingestion	1E-03	2E-01	2E-01		6E-02
Groundwater	Dermal	8E-06	9E-04	9E-04		4E-04
	Ingestion				1E-03	
Surface Water	Dermal	1E-05	1E-05	1E-05	3E-06	5E-06
	Inhalation of					
	Fugitive					
	Dust/Volatiles					
Air	from Soil	2E-05	2E-05	1E-05	2E-06	8E-06
Fish	Ingestion	1E-01	1E-01	1E-01	2E-02	7E-03
Large Land Mammals	Ingestion	4E-05	4E-05	4E-05	6E-07	2E-07

 Table 7-1
 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
Small Land Mammals	Ingestion	4E-04	4E-04	4E-04	7E-06	2E-06
Birds	Ingestion	2E-03	2E-03	2E-03	5E-04	2E-04
Berries and Plants	Ingestion	9E-03	1E-02	5E-03	9E-05	3E-05
Total Excess Lifetime Cancer Risk		1E-01	3E-01	3E-01	3E-02	7E-02

# Table 7-1 Summary of Excess Lifetime Cancer Risks for Red Devil Mine

Note:

Shaded cell indicates excess lifetime cancer risk greater than 10<sup>-5</sup>.

Key:

RDC = Red Devil Creek

# Table 7-2 Summary of Hazard Indices for Red Devil Mine

Medium	Exposure Route	Fut Resic Sur Minec	ture lent - face l Area	Fut Resid Ma Proce Ar	ure ent - in ssing ea	Fut Resic RI Downs Alluvia	ture lent - DC stream al Area	Recrea Subsi Us	itional/ stence ser	Mine Worker
		Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult
Soil	Ingestion	12	116	30	284	10	94	8	74	22
5011	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
Groundwater	Ingestion	6	13	1,330	3,102	1,330	3,102			950
Groundwater	Dermal	0.2	0.5	34.9	103.0	34.9	103.0			24.9
Sumface Water	Ingestion							0.0	0.0	
Surface water	Dermal	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Ain	Inhalation of Fugitive Dust/ Volatiles from Soil	4.6	4.6	56	56	18	18	14	14	13
Air Inhalati Volatile Ground water	Inhalation of Volatiles from Ground- water	0.0	0.0	2.8	2.8	2.8	2.8			
Fish	Ingestion	441	987	441	987	441	987	88	197	60
Large Land Mammals	Ingestion	8	18	8	18	8	18	0.1	0.3	0.1
Small Land Mammals	Ingestion	10	22	10	22	10	22	0.2	0.4	0.1
Birds	Ingestion	14	30	14	30	14	30	4.5	10	3.1
Berries and Plants	Ingestion	29.4	66	170.1	381	48.4	108	1.3	3.0	0.9
Tot	tal Hazard Index	535	1,329	2,107	5,063	1,926	4,550	125	360	1,092

Notes:

Shaded cell indicates Hazard Index greater than 1.0.

Hazards were calculated based on an exposure duration of 30 years, as described in Section 6.2.4.3. See Appendix J, Tables J-6 through J-9 in the RI Report.

Key:

RDC = Red Devil Creek

#### 7.2.6 Human Health Risk Assessment Supplement

The BLM conducted an RI Supplement and HHRA Supplement to address data gaps associated with Kuskokwim River sediments that were not addressed as part of the initial RI effort, specifically to assess the risks and hazards from potential exposure to COCs through direct contact and incidental ingestion of sediment, and consumption of fish from the Middle Kuskokwim River region. These additional investigations and HHRA Supplement are described below.

#### **RI Supplement**

In 2018, the BLM completed an RI Supplement to address data gaps that were not fully addressed in the initial RI. The RI Supplement augmented initial RI results by defining the extent of COC concentrations in the Kuskokwim River sediment and evaluating the risk to aquatic species potentially exposed to COCs to those sediments. The RI Supplement and HHRA and BERA supplements incorporated results the of the BLM regional study of fish tissue and movement in the middle section of the Kuskokwim watershed. The risk assessment supplements are discussed below.

#### **HHRA Supplement**

The combined results of the RI and RI Supplement sediment characterization were used to assess potential risks to human receptors that use the Kuskokwim River near and downstream from the Red Devil Mine. The results indicate that the Red Devil Mine is currently not a significant contributor of mercury or other metals to upper trophic level subsistence fish species in the Kuskokwim River. Further, the results demonstrate that the Red Devil Creek delta area is not attractive habitat for resident fish species, and therefore Red Devil Mine is not the source of mercury detected in resident fish in the Kuskokwim River watershed. The BLM developed a regional estimate of exposure from subsistence fish consumption that based on fish tissue data and applied to residents in Red Devil Village.

The final list of COPCs used in the RI HHRA were used for the HHRA Supplement. All metals identified as COPCs were assessed in the HHRA Supplement for both sediment and fish tissue. The receptors used in the HHRA Supplement are the same as were used in the HHRA. The following exposure pathways were evaluated in the HHRA Supplement:

- Dermal (skin) contact with sediments from the nearshore of the Kuskokwim River;
- Incidental ingestion of sediment from the nearshore of the Kuskokwim River; and
- Consumption of fish harvested from the Kuskokwim River.

EPCs for fish tissue and nearshore sediment were estimated using the 95-percent UCL values. Sediment was considered nearshore if it was likely to be submerged in less than 2 feet of water for at least part of the time between early June and late August.

The HHRA Supplement for the Kuskokwim River assessment area indicated that direct exposure (incidental ingestion and dermal exposure) to Kuskokwim River sediment near the Red Devil Mine results in noncancer hazards that do not exceed acceptable hazards as defined by the EPA and ADEC. Cancer risks from exposure to Kuskokwim River sediment for all receptors are within the acceptable EPA excess lifetime cancer risk range of  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$ . For residents and recreational/subsistence users, the excess lifetime cancer risk is  $4 \times 10^{-5}$ , slightly above the

ADEC standard of 1 x  $10^{-5}$ . Arsenic is the only contaminant associated with carcinogenic risk at the site.

Potential exposure to methylmercury and arsenic was assessed using data from fish samples collected along a 254-mile stretch of the middle Kuskokwim River and a number of tributaries. The sampling area extended well up- and downstream of the Red Devil Mine. Assessment estimated cancer risk levels above both ADEC and EPA standards and noncancer hazards above ADEC or EPA standards. The cancer risks are primarily driven by consumption of arsenic in northern pike and whitefish. The noncancer hazards are primarily driven by consumption of methylmercury in northern pike, and arsenic and methylmercury in whitefish. Assessment of potential cancer risks and noncancer hazards from exposure to fish on a regional basis are not specifically tied to the Red Devil Mine.

# 7.3 Baseline Ecological Risk Assessment

# 7.3.1 Baseline Ecological Risk Assessment

A BERA was conducted for the Red Devil Mine as part of the RI in accordance with ADEC and EPA's ecological risk assessment guidance. An assortment of ecologically relevant assessment endpoints were evaluated, including terrestrial plants, soil invertebrates, benthic macroinvertebrates, fish and other aquatic biota, terrestrial wildlife, and aquatic-dependent wildlife. For the BERA, the main steps are completion of a screening-level BERA, problem formulation, exposure assessment, risk characterization, and uncertainty analysis. The BERA was conducted using contaminant data from two primary sources: (1) surface soil, sediment, surface water, and vegetation data collected for the RI; and (2) fish (slimy sculpin) and benthic macroinvertebrate contaminant data collected from Red Devil Creek by the BLM as part of a regional study examining contaminants in aquatic biota in the Middle Kuskokwim River and tributaries. Methods and results of the BERA are presented in Chapter 6 of the final RI Report and summarized below.

The problem formulation step identifies site-related contaminants, potential ecological receptors, and potential exposure pathways. A conceptual site model was developed to identify the relationships between site-related contaminants and potential receptors. Assessment endpoints and measures are then established to guide the remaining steps of the risk assessment process. For the Red Devil Mine BERA, the following assessment endpoints were identified:

- Abundance, diversity, and primary production of:
  - Terrestrial plant species; and
  - Aquatic plant species.
- Abundance and diversity of:
  - Freshwater aquatic invertebrate community;
  - Freshwater benthic invertebrate community;
  - Soil invertebrate community;
  - Freshwater fish detritivore;
  - Freshwater semi-aquatic avian herbivore;
  - Terrestrial avian herbivore;

- Freshwater mammalian semi-aquatic mammalian herbivore;
- Terrestrial mammalian herbivore;
- Semi-aquatic avian invertivore;
- Terrestrial avian invertivore;
- Freshwater fish invertivore;
- Freshwater amphibian invertivore;
- Terrestrial mammalian invertivore;
- Freshwater avian piscivore;
- Terrestrial avian carnivore;
- o Terrestrial mammalian carnivore;
- o Freshwater mammalian carnivore; and
- Freshwater fish piscivore.

In general, the greatest HQ values were observed for antimony, arsenic, and mercury. The BERA risk results are discussed by assessment endpoint below.

- For the terrestrial plant community, seven contaminants were predicted to be COCs (antimony, arsenic, cobalt, manganese, mercury, nickel, and vanadium). The greatest HQ values were for antimony, arsenic, and mercury, and these contaminants have the greatest potential to adversely affect the terrestrial plant community at the site. Confidence in the COC list and magnitude of the HQ values is considered low, primarily because of the conservative nature of the soil screening levels for plants and because contaminant bioavailability in soil was not considered.
- For the soil invertebrate community, seven contaminants were predicted to be COCs. The greatest HQ values were for antimony, arsenic, and mercury. Confidence in the COC list and magnitude of the HQ values is considered low, primarily because of the conservative nature of the soil 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 synthetic precipitation leaching procedure and mercury selective sequential extraction results), the magnitude of the HQ values for antimony, arsenic, and mercury would be significantly lower.
- For aquatic biota (e.g., periphyton, amphibians, benthic macroinvertebrates, and fish) exposed to surface water, five COCs were identified based on comparing chemical concentrations in surface water with water quality criteria. The greatest HQ values were for antimony, arsenic, and mercury. Potential risk to aquatic life from arsenic, iron, and manganese in surface water in Red Devil Creek appears to be localized to an area near where a seep discharges to the creek in the Main Processing Area.
- For the fish community in Red Devil Creek, arsenic, antimony, mercury, and possibly selenium were predicted to be COCs based on comparing chemical concentration in whole-body sculpin samples with tissue screening concentrations. Confidence in the risk estimates is considered moderate to low, depending on the contaminant.
- For the benthic macroinvertebrate community, nine contaminants were predicted to be COCs based on comparing contaminant concentrations in sediment with sediment screening levels. 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, a benthic macroinvertebrate survey conducted in Red Devil Creek identified no adverse impacts to abundance and diversity of benthic macroinvertebrates compared with nearby reference creeks. The site-specific survey is considered to be a more reliable assessment method and suggests no impacts to the benthic community from site-related contaminants. Lastly, potential risks to benthic macroinvertebrates also were assessed by comparing contaminant levels in benthic macroinvertebrate tissues with critical tissue concentrations. This assessment method identified only methylmercury as a COC for the benthic macroinvertebrate community.

- For the terrestrial avian invertivore assessment endpoint (represented by the American robin), arsenic and lead were identified as COCs. Confidence in the arsenic and lead risk estimates is considered low for two reasons: (1) site-specific contaminant bioavailability in soil was not quantitatively considered; and (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms). In addition, for lead, the risk is driven by a highly elevated lead concentration in surface soil at one location. Hence, potential risks to the American robin from lead at the Red Devil Mine are highly localized.
- For the terrestrial mammalian invertivore assessment endpoint (represented by the masked shrew), antimony, arsenic, cadmium, copper, lead, nickel, selenium, thallium, and zinc were identified. The greatest HQ values were for antimony and arsenic. Confidence in the risk estimates is considered low for two reasons: (1) site-specific contaminant bioavailability in soil was not quantitatively considered; and (2) literature-based models were used to estimate contaminant concentrations in prey (earthworms).
- For the terrestrial avian herbivore assessment endpoint (represented by the spruce grouse), six contaminants (antimony, arsenic, beryllium, mercury, thallium, and vanadium) were predicted to be COCs. The greatest HQ values were for arsenic and mercury. Confidence in the arsenic and mercury risk estimates is considered low. For the terrestrial mammalian herbivore assessment endpoint, represented by the tundra vole, antimony, arsenic, and manganese were identified as COCs. The greatest HQ value was for antimony. Confidence in the risk estimates is considered low.
- For the terrestrial carnivorous bird assessment endpoint (represented by the northern shrike), no HQ values were greater than 1.
- For the terrestrial carnivorous mammal assessment endpoint (represented by the least weasel), no COCs were identified.
- For the semi-aquatic avian invertivore assessment endpoint (represented by the common snipe [*Gallinago gallinago*]), five COCs (antimony, arsenic, beryllium, selenium, and thallium) were identified. The greatest HQ was for arsenic. Confidence in the arsenic risk estimate for the snipe is considered moderate.
- For the semi-aquatic mammalian herbivore assessment endpoint (represented by the beaver), arsenic was identified as a COC. Confidence in the arsenic risk estimate for the beaver is considered low.

- For the semi-aquatic avian herbivore assessment endpoint (represented by the greenwinged teal), no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated.
- For the avian piscivore assessment endpoint (represented by the belted kingfisher [*Megaceryle alcyon*]), no HQ values were greater than 1, but potential risks from antimony, beryllium, and thallium could not be quantitatively evaluated.
- For the mammalian piscivore assessment endpoint (represented by the mink), antimony, arsenic, and selenium were identified as COCs. Confidence in the risk estimates for the mink are considered moderate to high.

All risk assessments include elements of uncertainty, and the BERA for the Red Devil Mine is no exception. Noteworthy sources of uncertainty in the BERA and their potential effect on the risk results are summarized in the RI Report.

Several contaminants identified as BERA COCs at the Red Devil Mine occur at concentrations in site media that are similar to background. Specifically, beryllium, manganese, vanadium, and selenium were predicted to pose a potential risk to one or more ecological receptors at the Red Devil Mine, but their concentrations in site media lie within the range of background.

Proposed ecological risk-based cleanup levels for arsenic, antimony, and mercury in surface soil and sediment were developed for the Red Devil Mine and detailed in Tables 6-85 through 6-87 in the RI Report. Exceedances of soil and sediment remedial goals are greatest in the Main Processing Area.

#### 7.3.2 Baseline Ecological Risk Assessment Supplement

As noted above, the BLM completed an RI Supplement to address data gaps associated with Kuskokwim River sediments that were not addressed as part of the initial RI effort. The RI Supplement included a BERA Supplement.

The BERA Supplement was focused on aquatic-dependent receptors that may use the Kuskokwim River near the Red Devil Mine, including benthos, fish, and wildlife. After the final RI Report was completed, the BLM collected additional data from the Kuskokwim River near the Red Devil Mine and from the middle Kuskokwim River region as described above. These data were used to help understand potential risks to aquatic-dependent receptors that use the Kuskokwim River near and downstream from the Red Devil Mine.

For ecological receptors, no COCs are identified because the BERA Supplement for the Kuskokwim River identified only marginal risks to the assessment endpoints. The BERA Supplement for the Kuskokwim River assessment area identified only marginal risks to the assessment endpoints evaluated when conservative approaches were used to model bioaccumulation. The following points were drawn from the BERA Supplement:

• When using site biota sediment accumulation factors (BSAFs) and trophic transfer factors (TTFs) to model food-chain bioaccumulation, no risks were predicted for herbivorous birds (represented by the green-winged teal), invertivorous birds (represented by the common snipe), piscivorous birds (represented by the belted kingfisher),

piscivorous mammals (represented by the mink), forage fish (represented by the sculpin), or benthic macroinvertebrates.

- Because BSAFs often increase with decreasing contaminant concentrations in sediment, BSAFs and TTFs based on data from reference creeks in the middle Kuskokwim River region also were used to model bioaccumulation. When background BSAFs and TTFs were used to model bioaccumulation, marginal potential risks were predicted for invertivorous birds (common snipe) from mercury (HQ = 1.2) and selenium (HQ = 1.1), piscivorous birds (belted kingfisher) from selenium (HQ = 1), piscivorous mammals (mink) from selenium (HQ = 1.2), benthic macroinvertebrates from mercury (HQ = 4.2), and forage fish from mercury (HQ = 1.8). However, as discussed in the RI Supplement Report, selenium risks to the common snipe, belted kingfisher, and mink are from background. As noted in RI Supplement report, using only background BSAFs and TTFs to model bioaccumulation likely overestimates risk in the Kuskokwim River assessment area by a factor of two to four.
- By assuming that aquatic-dependent herbivorous birds (green-winged teal) feed only on periphyton from the Kuskokwim River, a potential risk was identified from vanadium (HQ = 8). However, as discussed in the RI Supplement, vanadium risks are from background.
- Sediment toxicity testing (amphipod) was the strongest line of evidence used to evaluate potential impacts to the benthic macroinvertebrate community in the Kuskokwim River near the Red Devil Mine. Low to moderate effects on survival, growth, and/or biomass were identified in three of 10 site samples, but there was no relationship between these effects and sediment concentrations of antimony, arsenic, mercury, and/or methylmercury, the principal site-related contaminants. Instead, the effects appeared to be the result of differences in sediment texture and/or total organic carbon content between the site and reference samples, and/or the result of non-site-related metals (iron, manganese, and nickel) that appear to be naturally elevated in Kuskokwim River sediment.

#### 7.4 Basis for Action

Contamination resulting from releases of hazardous substances at and from the Red Devil Mine presents an unacceptable risk to human health and the environment. Human receptors may be harmed by exposure to hazardous substances present in tailings/waste rock, soil, and creek sediments that pose excessive cancer risks or health hazards. Terrestrial ecological receptors may be harmed by exposure to hazardous substances in soil and sediments above levels that are protective of terrestrial and aquatic life, with some metals posing potential ecological risks significantly higher than an HQ of 1. The response action selected in this ROD is necessary to protect the public health and the environment from risks posed by actual and threatened releases of hazardous substances into the environment.

# 8.0 **REMEDIAL ACTION OBJECTIVES**

Remedial Action Objectives (RAOs) are goals for protecting human health and the environment that address specific exposure routes and receptors. RAOs establish the requirements used to identify and evaluate remedial alternatives to ensure that the Selected Remedy protects human health and the environment from hazardous substances released into the environment as a result of mining activities. To provide this protection, media-specific objectives that identify major contaminants and associated media-specific remedial goals were developed. These goals specify the COCs, exposure routes and receptors, and an acceptable maximum contaminant level for the long-term protection of receptors. Achieving the RAOs should reduce risks to levels acceptable to the ADEC and EPA. Human receptors evaluated included potential future residents, recreational site visitors, and potential future on-site workers. Ecological receptors evaluated included a range of terrestrial and aquatic wildlife species known to be present at or near the site, and vegetation. The major exposure media and potential receptors are:

- Tailings/waste rock and contaminated soil (potential human visitors/residents, plants, and terrestrial and aquatic wildlife);
- Red Devil Creek sediments that have been impacted by tailings/waste rock (potential human visitors/residents);
- Groundwater in the Main Processing Area (potential human visitors/residents);
- Nearshore Kuskokwim River sediment (potential human visitors/residents);
- Air/dust (potential human visitors/residents); and
- Fish, mammals, birds, and plants/berries (potential human visitors/residents).

The following subsections present the development of RAOs for contaminated materials. Allowable exposures based on applicable standards and the HHRAs and BERAs are then presented and remedial goals (see Section 8.3) are developed as a result.

#### 8.1 Medium-Specific Objectives

The BLM developed the following RAOs for tailings/waste rock, soil, Red Devil Creek sediment, and groundwater based on the RI, HHRA, and BERA:

- Prevent or reduce human exposure (through ingestion or dermal contact) to COCs in tailings and waste rock, soils in the Main Processing Area, Red Devil Creek sediment, and Kuskokwim River sediment at concentrations above remedial goals;
- Prevent or reduce human exposure (through inhalation) to COCs in dust from tailings/ waste rock, and soil at concentrations above remedial goals;
- Prevent or reduce human exposure (through ingestion) to COCs in fish in Red Devil Creek and in mammals and birds that may inhabit the Main Processing Area to acceptable levels;
- Prevent or reduce exposure of plants, fauna, and terrestrial wildlife in the Main Processing Area; aquatic-dependent wildlife that feed in or near Red Devil Creek; fish in Red Devil Creek; and sediment-dwelling organisms from COCs in tailings and waste rock, soil in the Main Processing Area, and Red Devil Creek sediment at concentrations above remedial goals;

- Prevent or reduce migration of COCs to surface water from erosion of tailings/waste rock;
- Prevent or reduce leaching of COCs from tailings/waste rock to groundwater; and
- Prevent or reduce human exposure (through ingestion inhalation, or dermal contact) to antimony, arsenic, and mercury in groundwater at concentrations above remedial goals.

The BLM developed the following RAOs for nearshore Kuskokwim River sediment and materials within the lower delta based on results of the HHRA Supplement:

- Reduce future human exposure (through dermal contact and incidental ingestion) to arsenic in materials within the lower delta and nearshore Kuskokwim River sediments at concentrations above remedial goals; and
- Reduce potential migration of materials within the lower delta to downriver locations where human exposure to nearshore sediments at concentrations above remedial goals could occur.

The BERA Supplement for the Kuskokwim River identified only marginal risks to the assessment endpoints (E & E 2018). Therefore, Kuskokwim River sediment RAOs based on protection of ecological receptors were not developed.

RAOs for surface water are not applicable to the Red Devil Mine because surface water has not been demonstrated to be a pathway of concern for the site. RAOs for air are not necessary, because the soil RAOs address the source of potential airborne soil particles that pose site risks.

# 8.2 Applicable or Relevant and Appropriate Requirements

The Applicable or Relevant and Appropriate Requirements (ARARs) identified for the Selected Remedy in this ROD are presented in detail in Appendix A and are briefly discussed in Sections 10.1.2 and 13.2.

# 8.3 Remedial Goals and Proposed Cleanup Levels

Remedial goals are established by calculating cleanup levels that would not pose an unacceptably high risk of health impacts, or by calculating the "background value"—the levels that naturally occur in and around the site. Many of the metals at the Red Devil Mine occur naturally and, in some cases, background values of these metals are higher than risk-based cleanup levels. It is not practical to clean up the metals to below naturally occurring levels. For carcinogenic compounds, the cleanup level is typically set at a range of one in  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  for excess cancer risk.

#### Tailings/Waste Rock, Soil, and Red Devil Creek Sediment

Based on the RAOs listed above, the BLM developed potential remedial goals for specific exposure media for the Red Devil Mine. The following are potential remedial goals analyzed for tailings/waste rock, contaminated soil, and contaminated Red Devil Creek sediment based on the RI, HHRA, and BERA:

• Site-specific, risk-based alternative cleanup levels, in accordance with 18 AAC 75.341 (see Section 6.4 of the RI Report);

- Site-specific RBCLs for protection of ecological receptors (see Section 6.4 of the RI Report);
- Chemical-specific ARARs for soil in accordance with 18 AAC 75.341 (see Section 10.1 of this ROD); and
- Site-specific background values developed in the RI Report (see Section 4.1 of the RI Report).

Potential remedial goals for air and biotic exposure media (fish, mammals, birds, and berries) were not identified because the remedial goals developed for tailings/waste rock and soil are expected to remedy these exposure pathways.

# **Kuskokwim River Sediment**

RBCLs were not developed for Kuskokwim River sediment in the RI. Based on the results of the HHRA Supplement for Kuskokwim River sediments (see RI Supplement Report Chapter 6), all noncarcinogen hazards are at or below both EPA and ADEC standards. Therefore, an RBCL for noncancer endpoints was not developed for any chemical. The cancer risk for a residential and recreational/subsistence user was within the EPA's risk range but above the ADEC's cancer risk standard. Arsenic is the only carcinogen in Kuskokwim River sediment. Based on the exposure scenarios for the resident and recreational/subsistence user—a risk-based concentration in Kuskokwim River sediment equivalent to a cancer risk of 1 x 10<sup>-5</sup>, the ADEC's cancer risk standard—an RBCL for arsenic in sediment of 69.1 milligrams per kilogram (mg/kg) was developed. The BERA Supplement for the Kuskokwim River identified only marginal risks to the assessment endpoints; therefore, no RBCLs for Kuskokwim River sediment for ecological receptors were developed.

#### Groundwater

Groundwater COC concentrations in the area near Red Devil Creek are strongly influenced by the presence of tailings and waste rock. Under the selected alternative, tailings and waste rock would be excavated. To develop appropriate remedial goals to address the potentially contaminated groundwater that would be present in the Main Processing Area and Red Devil Creek valley following excavation such as described for the selected alternative, it was necessary to account for the influence of natural mineralization on the groundwater COC concentrations.

Actual concentrations of antimony, arsenic, and mercury in groundwater after excavation cannot presently be predicted with confidence. However, it is reasonable to assume that concentrations of COCs in groundwater after excavation would be similar to those observed in bedrock in the upper elevations of the watershed. In 2019, the BLM completed additional characterization of bedrock, soil, tailings/waste rock, and groundwater. Results of the additional groundwater characterization were integrated with previous results to refine the understanding of groundwater depths, gradients, and flow paths; groundwater quality; and factors and processes influencing groundwater and surface water quality, including naturally mineralized bedrock in addition to tailings/waste rock and contaminated soil. Results were synthesized in the Groundwater and Surface Water Report that was finalized in 2019.

In coordination with the ADEC and EPA, the BLM developed an approach to attempt to account for the impacts of natural mineralization in bedrock and estimate background groundwater

values. The rationale, methods, and results of the background groundwater evaluation are presented in the 2019 Groundwater and Surface Water Report. The background values were used to develop groundwater remedial goals to satisfy requirements for the FS Supplement. These background values are presented in Table 8-1. The BLM will develop long-term groundwater quality objectives based on post-remediation conditions and background water quality data.

#### **Remedial Goal Selection**

The BLM selected remedial goals through a process that balances applicable regulatory criteria, site-specific RBCLs, and site-specific background values relevant to the media addressed in the FS Report and FS Supplement Report. The remedial goal selection process was conducted as follows:

- If chemical-specific ARAR concentrations and site-specific RBCLs were below background values, the background value was selected as the remedial goal because cleanup of contaminants below natural background levels is not authorized by CERCLA.
- If chemical-specific ARAR concentrations and site-specific RBCLs were above background values, the lowest of the ARAR concentration or RBCL was selected as the remedial goal.
- If either the ARAR concentration or site-specific RBCL was greater than the background value, the greater value of the ARAR or site-specific RBCL was selected as the remedial goal.

Table 8-1 summarizes the remedial goal values by media.

Contaminant of Concern	Chemical- Specific ARAR Concentration	Calculated Human Health RBCL for Future Resident <sup>(1)</sup>	Lowest Calculated Ecological RBCL <sup>(2,3)</sup>	Background Value <sup>(4)</sup>
Tailings/Waste Rock an	nd Soil (mg/kg)			
Antimony	4.6 <sup>(5)</sup>	41	14	52.2 <sup>(6)</sup>
Arsenic	0.2(5)	6.1	18	28.58(6)(7)
Barium	2,100 <sup>(5)(6)</sup>	-	-	266
Chromium	1x10 <sup>-5(5)</sup>	-	-	30 <sup>(6)</sup>
Lead	400(6)(8)	-	-	14.3
Mercury	0.36 <sup>(5)</sup>	30	34.5	3.92 <sup>(6)</sup>
Nickel	340 <sup>(5)(6)</sup>	-	-	52.2
Selenium	6.9(5)(6)	-	-	0.37
<b>Diesel-Range Organics</b>	250 <sup>(9)(6)</sup>	-	-	-
<b>Red Devil Creek Sedim</b>	ent (mg/kg)			
Antimony	-	-	113(6)	0.54
Arsenic	-	130(6)	445	65
Chromium	-	-	-	20.4(6)
Copper	-	-	-	21.7 <sup>(6)</sup>
Manganese	-	-	-	579 <sup>(6)</sup>
Mercury	-	-	-	0.18(10)
Methylmercury	-	-	-	0.177 <sup>(6)</sup>
Nickel	-	-	-	32 <sup>(6)</sup>
Kuskokwim River Sedi	ment (mg/kg)			
Arsenic	_	69.1 <sup>(6)</sup>	-	13.4

# Table 8-1 Remedial Goals

## Table 8-1 Remedial Goals

Contaminant of Concern	Chemical- Specific ARAR Concentration	Calculated Human Health RBCL for Future Resident <sup>(1)</sup>	Lowest Calculated Ecological RBCL <sup>(2,3)</sup>	Background Value <sup>(4)</sup>
Groundwater (µg/L)				
Antimony	7.8 <sup>(11)</sup>	6.0	-	12.99 <sup>(6)</sup>
Arsenic	0.52 <sup>(11)</sup>	0.27	-	444.1(6)
Mercury	0.52 <sup>(11)</sup>	4.3	-	1.628(6)

Notes:

RBCLs were developed using the exposure equations and parameters identified in the HHRA (RI Report Chapter 6) and back calculating a target concentration in each individual medium, and RBCLs for noncarcinogens were calculated based on child exposure for the resident and recreational/subsistence user since that represents the most highly potentially exposed receptor. The RBCLs do not account for cumulative risk resulting from exposure to multiple contaminants simultaneously.

(2) Based on No Observed Adverse Effect Level.

(3) Ecological RBCLs are based on information presented Section 6.4.2 of the RI Report.

- (4) Background values for tailings/waste rock and soil represent the higher of the values calculated for surface soil and subsurface soil.
- (5) 18 AAC 75.341(c) Table B1 Migration to Groundwater exposure pathway.
- (6) Numerical value selected as remedial goal. Background values for groundwater were estimated to satisfy requirements to develop remedial goals for the FS Supplement as described in Section 5.4.
- (7) The arsenic remedial goal for tailings/waste rock and soil represents the naturally occurring background values for soil and arsenic. The remedial goal for Red Devil Creek sediments represents the risk of 1 x 10<sup>-5</sup> for a future resident. Since the background values are higher than calculated risk-based levels, the total residual excess lifetime cancer risk, as modeled in the HHRA, would exceed the ADEC's standard of 1 x 10<sup>-5</sup>.
- (8) 18 AAC 75.341(c) Table B1 Under 40-inch climate zone, Human Health exposure pathway
- (9) 18 AAC 75.341(c) Table B2 Under 40-inch climate zone, Migration to Groundwater exposure pathway.
- (10) While the background value for mercury in Red Devil Creek sediment is 0.177 mg/kg, the selected sediment remedial goal is the same as the soil remedial goal of 3.92 mg/kg. Cleanup to the sediment background value would not be achievable due to the intermixing and proximity of soil materials to the sediment bed of Red Devil Creek.
- (11) Groundwater chemical specific ARARs consist of Safe Drinking Water Act Maximum Contaminant Levels and State of Alaska groundwater cleanup levels identified in 18 AAC 75.345 Table C. The lower of the two chemical specific ARARs values for each COC is proposed.

Key:

AAC	=	Alaska Administrative Code	μg/L	= micrograms per liter
ADEC	=	Alaska Department of Environmental Conservation	RBCL	= risk-based cleanup level
ARAR	=	applicable and relevant or appropriate requirement	RI	= Remedial Investigation
COC	=	contaminant of concern	-	= No applicable regulatory criterion is
HHRA	=	human health risk assessment		available or risk-based level calculated
mg/kg	=	milligrams per kilogram		

#### 8.4 Basis for Remedial Action Objective Selection

The BLM developed the RAOs summarized in Section 8.1 to protect persons that might visit the site and ecological receptors.

# 9.0 DESCRIPTIONS OF ALTERNATIVES

This section summarizes the remedial alternatives developed in the FS for the Red Devil Mine. The remedial alternatives were constructed by combining general response actions, technology types, and process options. Remedial alternatives are developed to provide adequate protection of human health and the environment; achieve RAOs; meet ARARs; and permanently and significantly reduce the volume, toxicity, and/or mobility of site-related contaminants. Remedial alternatives are also developed to address the scope and complexity of site problems and evaluated using the criteria outlined in Section 300.430(e)(9) of the NCP. The 2016 FS presented four primary remedial alternatives to address tailings/waste rock, soil, and Red Devil Creek sediment contamination at the site, referred to as "mine site alternatives." In addition, Mine Site Alternative 3 was subdivided into four options.

The following sections first describe the original mine site alternatives developed in the 2016 FS, then the groundwater and Kuskokwim River sediment alternatives developed in the 2019 FS. Finally, the sitewide alternatives that BLM developed by combining the mine site, groundwater, and Kuskokwim River alternatives are discussed last. The sitewide alternatives are those currently under consideration.

#### 9.1 Description of Mine Site Alternatives

The remedial alternatives presented in the 2016 FS are outlined below.

#### **Mine Site Alternative 1: No Further Action**

Under this alternative, the tailings/waste rock, contaminated soil, creek sediment, and Kuskokwim River sediment would remain in their current locations, and groundwater contamination would not be actively monitored. The gate and warning signs that have been installed as part of previous response actions would remain in place but would not be maintained.

#### Mine Site Alternative 2: Institutional and Access Controls through Fencing and Signs

Under Alternative 2, contaminated tailings, soil, and Red Devil Creek and Kuskokwim River sediments would be left in place, and active remediation would be limited to erecting exclusion fencing and signage to reduce the potential for potential receptors to gain access to the site and become exposed to on-site COCs. Land use restrictions would be established at the site to restrict future human exposure by limiting activity, use, and access to the property.

#### Mine Site Alternative 3: Excavation of Solid Materials and On-site Consolidation

Under Mine Site Alternative 3, the tailings/waste rock, soil, Red Devil Creek sediment in the Main Processing Area, and areas of Kuskokwim sediment would be excavated and consolidated in an on-site repository. The final configuration of the repository would be one of four options. In all four options, the on-site repository would be capped with a low permeability cover. The four options are:

- A The repository would have no bottom liner, and Monofill #2 would be closed in place with a low permeability cover like that placed over the larger repository.
- B The repository would have a bottom liner and leachate collection system, and Monofill #2 would be closed in place with a low permeability cover like that placed over the larger repository.

- C The repository would have no bottom liner, and Monofill #2 would be deconstructed, and the associated tailings would be moved into the larger repository. The rest of Monofill #2 contents and Hypalon liner would be disposed of at an off-site location.
- D The repository would have a bottom liner and leachate collection system. Monofill #2 would be deconstructed, and the associated tailings would be moved into the larger repository. The rest of the Monofill #2 contents and the Hypalon liner would be disposed of at an off-site location.

#### Mine Site Alternative 4: Excavation of Solid Materials and Off-site Disposal

Under Alternative 4, the 210,000 cubic yards of tailings/waste rock, soil, and Red Devil Creek sediment in the Main Processing Area, and areas of Kuskokwim sediment would be excavated as in Mine Site Alternative 3. However, the contents of Monofills #1, #2, and #3 would also be excavated and all excavated material would be transported off site for disposal.

#### 9.2 Groundwater (GW) Alternatives

The 2019 FS Supplement developed and analyzed remedial alternatives to address contaminated groundwater and sediment in the Kuskokwim River. The 2019 FS Supplement groundwater alternatives are described below.

#### **Alternative GW1: No Action**

Under the No Action alternative, contaminated groundwater at the site would remain and no action would be taken to reduce the potential for human or ecological receptor exposure to COCs or to reduce migration. Maintenance or monitoring would not be performed under this alternative.

#### **Alternative GW2: Institutional and Access Controls**

Under Alternative GW2, warning signs would be installed along the perimeter at intervals of approximately 100 yards. Land use restrictions would be established at the site to restrict future human exposure by limiting activity, use, and access to the property. Alternative GW2 is similar to Mine Site Alternative 2.

#### 9.3 Kuskokwim River Sediment (KR) Alternatives

The 2019 FS Supplement developed and analyzed remedial alternatives to address contaminated sediment in the Kuskokwim River. The 2019 FS Supplement Kuskokwim River alternatives are described below.

#### **Alternative KR1: No Action**

Under the No Action alternative, contaminated sediments and materials within the lower delta at the site would remain at their current location and in their current condition. No action would be taken to reduce the potential for human or ecological receptor exposure to COCs or to prevent their off-site migration. Maintenance and monitoring would not be performed under this alternative.

#### **Alternative KR2: Institutional Controls**

Under Alternative KR2, contaminated sediments and materials within the lower delta would be left in place, and active remediation would be limited to erecting warning signs to reduce the

potential for human receptors to become exposed to on-site COCs. Alternative KR2 is similar in scope and RAO conformance to Mine Site Alternative 2.

#### Alternative KR3: Monitored Natural Attenuation

Under Alternative KR3, contaminated sediments and materials within the lower delta would be left undisturbed in place. Naturally occurring processes in the Kuskokwim River and Red Devil Creek delta are expected to reduce the COC concentrations over time. River sediment would be monitored periodically to confirm that concentrations are decreasing over time.

#### **Alternative KR4: Limited Dredging**

Alternative KR4 involves dredging approximately 18,000 cubic yards of material along the front of the delta at the mouth of Red Devil Creek. The dredged material would be consolidated in the on-site repository under Alternative KR4A and sent to an off-site disposal facility under Alternative KR4B. Alternative KR4A is similar in scope and RAO conformance to Mine Site Alternative 2. Alternative KR4B is similar in scope and RAO conformance to Mine Site Alternative 4.

#### Alternative KR5: Nearshore Sediment Removal

Under Alternative KR5, approximately 18,000 cubic yards of material along the front of the delta at Red Devil Creek would be dredged. In addition, approximately 300 cubic yards of nearshore Kuskokwim River sediments located downriver of the Red Devil Creek delta would be dredged. Under Alternative KR5A, the dredged material would be consolidated in the on-site repository. Under Alternative KR5AB, the dredged material would be sent to an off-site disposal facility. Alternative KR5A is similar in scope and RAO conformance to Mine Site Alternative 3. Alternative KR5B is similar in scope and RAO conformance to Mine Site Alternative 4.

#### 9.4 Sitewide Alternatives

The BLM combined the various alternatives evaluated in both the 2016 FS and the 2019 FS Supplement into sitewide remedy alternatives. The sitewide remedy alternatives represent a logical grouping of the 2016 FS and 2019 FS Supplement alternatives described above because they combine response actions of similar scope and RAO conformance. This section discusses the sitewide alternatives presented in the Proposed Plan that are being evaluated to identify the selected sitewide remedy.

#### Alternative SW1 – No Further Action

Interim cleanup actions have already been undertaken at the Red Devil Mine. These actions included demolishing mining structures and equipment, removing hazardous materials to off-site disposal locations, consolidating contaminated materials into the lined Monofill #2, stabilizing a portion of the on-site tailings and installation of erosion control structures in Red Devil Creek, and installing warning signs and a gate at the entrance to the mine. Since these actions have already been completed at the site, they are considered to be part of the SW1 – No Further Action alternative. The No Further Action alternative represents the baseline against which other alternatives for the Red Devil Mine can be compared.

Under this alternative, the tailings, waste rock, contaminated soil, creek sediment, and Kuskokwim River sediment would remain in their current locations, and groundwater

contamination would not be actively monitored. The gate and warning signs that have been installed as part of previous response actions would remain in place but would not be maintained.

#### Alternative SW2 – Institutional and Access Controls

Under Alternative SW2, contaminated tailings, soils, and sediments would be left in place, and active site control would be limited to erecting exclusion fencing to reduce the potential for potential receptors to gain access to the site and become exposed to on-site COCs. Institutional controls (ICs) in the form of land use restrictions would be established at the site to restrict future human exposure by limiting activity, use, and access to the property. Establishing ICs that restrict site access has implications for long-term management of the land. The long-term retention or disposal of the site lands by the government will involve development of a site management strategy separate from the CERCLA process.

The fencing would be constructed of material 16 gauge or heavier suitable to resist subarctic environments. Gates would be installed for controlled access and secured. The fence and gate material would consist of 1-inch horizontal by 2-inch vertical galvanized welded wire, 72 inches in height. During the detailed design phase, the potential use of a finer mesh fence material to exclude additional ecological receptors would be evaluated. The exclusion fence material would be buried a minimum of 12 inches BGS, leaving approximately 60 inches above the ground. It has been assumed that approximately 5,000 linear feet of fencing would be required. Warning signs would be installed along the perimeter fencing at the mine site at intervals of approximately 100 yards.

With contaminated tailings, soils, and sediments left in place, five-year reviews meeting the requirements in Section 121 of CERCLA would be performed. The five-year review would assess the protectiveness of the remedy by evaluating whether the remedy functions as intended, exposure assumptions are still valid, and new data have been obtained that could alter its effectiveness.

# Alternative SW3 – Excavation of Tailings, Waste Rock, Soils, and Sediments; Solidification (Treatment); On-site Consolidation; and Capping

Alternative SW3 involves extensive excavation of tailings/waste rock and contaminated soils and creek sediments, and on-site disposal in the northwestern portion of the mine site. The ARAR analysis developed for Alternative SW3 identified the Resource Conservation and Recovery Act (RCRA) as an applicable requirement. Because RCRA is identified as an ARAR, a RCRA Corrective Action Management Unit (CAMU), is established at the Red Devil Mine through approval of this ROD. The CAMU designation provides a framework for appropriately managing wastes on-site. By designating the proposed repository as a CAMU, a non-land-based unit, material can be treated and subsequently consolidated into a repository without triggering compliance with minimum technology requirements or land disposal restriction treatment standards. Consistent with the intent of the CAMU regulations, use of a CAMU option at the Red Devil Mine provides the flexibility to implement a protective remedy compliant with ARARs and consistent with FS criteria without triggering additional requirements shown to be unnecessary for protection of human health and the environment. A more detailed description of the CAMU rule and how it is applied to the Red Devil Mine is provided in Section 3.1 of the FS.

Alternative SW3 includes four options, or "sub-alternatives," that are variations of the same general approach to the Sitewide Alternative 3 remedy. These sub-alternatives are summarized in Table 9-1 and described separately below.

Remedy Features	SW3A	SW3B	SW3C	SW3D
On-site Repository	Yes	Yes	Yes	Yes
Liner Under Repository	No	Yes	No	Yes
Excavate Monofill #2 and Consolidate in Repository	No	No	Yes	Yes

 Table 9-1 Options Evaluated under Alternative 3

Each of the sub-alternatives for Alternative SW3 involves the construction of an on-site repository for excavated waste materials. Figure 9-1 illustrates the conceptual location and dimensions of the repository in relation to the Main Processing Area and other major site features.

All the sub-alternatives have the following components in common:

- Implement ICs and access controls (fencing and signs) as described under Alternative SW2;
- Excavate approximately 210,000 cubic yards of tailings and waste rock, contaminated soil, and surficial delta material that contain COCs above the cleanup levels;
- Excavate sediment that contains COCs above the cleanup levels in Red Devil Creek;
- Excavate sediment that contains COCs above the cleanup levels in the area adjacent to the Kuskokwim River at the mouth of Red Devil Creek and in downgradient areas;
- Conduct solidification of excavated tailings that fail the TCLP test for arsenic;
- Consolidate all excavated and solidified materials in an on-site repository with a geomembrane cover, geocomposite drainage layer, rock cover layer, and run-on and runoff surface water controls;
- Re-grade exposed highly mineralized soil/bedrock in the Surface Mined Area, cap with locally obtained soil (loess), and construct run-on and runoff surface water controls;
- Conduct periodic maintenance and monitoring to evaluate remedy performance and effectiveness;
- Perform periodic monitoring of on-site groundwater quality; and
- Perform periodic sediment quality monitoring in the Kuskokwim River.

The quantities of material to be excavated are similar for all of the Alternative SW3 options; however, Alternatives SW3C and SW3D would involve approximately 1.3 percent more excavated material than Alternatives SW3A and SW3B due to the removal of Monofill #2. The

time necessary to implement all of the Alternative SW3 options is also similar and is expected to be approximately one to two construction seasons.

#### Alternative SW3A: Unlined Repository and Monofill #2 Covered In-Place

In addition to the common elements for all of the sub-alternatives, the primary elements specific to Alternative SW3A are:

- Close Monofill #2 in place by enhancing the existing cap; and
- Install a cover system for Monofill #2 using a geomembrane to prevent direct exposure to contaminated soil and tailings on the structure, and to inhibit leaching of contaminants to groundwater.

Under Alternative SW3A, the repository would not be constructed with a bottom liner. The repository performance and ongoing protectiveness would be assessed through regular groundwater monitoring. The present cover system on Monofill #2 would be enhanced by removing the tailings cover (for solidification), adding a geomembrane and a growth medium to the cover, and constructing run-on and runoff controls.



#### Alternative SW3B: Lined Repository and Monofill #2 Covered In-Place

In addition to the common elements for all of the sub-alternatives, the primary elements specific to Alternative SW3B are:

- Install a cover system for Monofill #2 using a geomembrane to prevent direct exposure to contaminated soil and tailings on the structure and to inhibit leaching of contaminants to groundwater.
- Install a high-density polyethylene bottom liner, drainage layer, and perforated leachate collection piping beneath the consolidated waste beneath the repository.
- Collect leachate via a sump and pump the leachate from the repository to an underground storage tank.
- Periodically transport collected leachate from the site via barge to an off-site treatment or disposal facility.

Under Alternative SW3B, the repository would be constructed with a bottom liner. Leachate generated within the repository would be collected and stored on site for eventual off-site disposal on a periodic basis. The repository performance and ongoing protectiveness would be assessed through regular groundwater monitoring. The present cover system on Monofill #2 would be enhanced by removing the tailings cover (for solidification), adding a geomembrane and a growth medium to the cover, and constructing run-on and runoff controls.

#### Alternative SW3C: Unlined Repository and Monofill #2 Excavated

In addition to the common elements for all of the sub-alternatives, the primary elements specific to Alternative SW3C are:

- Excavate 940 cubic yards of materials presently contained within Monofill #2 and approximately 1,700 cubic yards of tailings used to cover material on the monofill.
- Segregate contents presently contained within Monofill #2 that are not suitable for consolidation in the repository and transport these materials to a suitable off-site disposal facility. The remedial design will include detailed specifications for characterization, identification, and segregation of Monofill #2 contents not suitable for the repository, including but not limited to retort building materials, bricks, and metallic debris.
- Consolidate the tailings/soil contents and tailings cover of Monofill #2 in the on-site repository.

Under Alternative SW3C, the repository would not be constructed with a bottom liner. The repository performance and ongoing protectiveness would be assessed through regular groundwater monitoring. Monofill #2 would be excavated, and the area would be regraded. The contents of Monofill #2 would be deposited in the repository. Some materials presently contained in Monofill #2 that are not suitable for disposal in the repository would be shipped off site for disposal.

#### Alternative SW3D: Lined Repository and Monofill #2 Excavated

Alternative SW3D combines key elements of Alternatives SW3B and SW3C. The primary elements specific to Alternative SW3D are:

- Excavate 940 cubic yards of materials presently contained within Monofill #2 and approximately 1,700 cubic yards of tailings used as cover material on the monofill.
- Segregate contents presently contained within Monofill #2 that are not suitable for consolidation in the repository and transport these materials to an off-site disposal facility.
- Consolidate the contents and tailings cover of Monofill #2 in the on-site repository.
- Install a high-density polyethylene bottom liner, drainage layer, and perforated leachate collection piping beneath the consolidated waste in the repository.
- Periodically transport collected leachate from the site via barge to an off-site treatment or disposal facility.

Under Alternative SW3D, the repository would be constructed with a bottom liner. Leachate generated within the repository would be collected and stored on site for eventual off-site disposal on a periodic basis. The repository performance and ongoing protectiveness would be assessed through regular groundwater monitoring. Monofill #2 would be excavated, and the area would be regraded. The contents of Monofill #2 would be deposited in the repository. Some materials presently contained in Monofill #2 that are not suitable for disposal in the repository would be shipped off site for disposal.

Alternative SW4 – Excavation of Contaminated Materials and Off-site Disposal. Similar to the options described under Alternative SW3, Alternative SW4 would involve excavation of tailings and waste rock, contaminated soil, and sediment in Red Devil Creek. All three monofills would also be excavated. All excavated material would be transported off site by barge via the Kuskokwim River for disposal at a licensed disposal facility outside of Alaska. This alternative includes capping of exposed highly mineralized bedrock in the Surface Mined Area. The quantity of material to be excavated under Alternative SW4 is the same for Alternatives SW3C and SW3D.

The primary elements of Alternative SW4 are:

- Excavate tailings and waste rock, contaminated soil, and exposed delta material that contain COCs above the cleanup levels;
- Excavate contaminated sediment in Red Devil Creek that contains COCs above the cleanup levels;
- Excavate the contents of the three monofills and backfill the open excavations;
- Re-grade exposed, highly mineralized soil/bedrock in the Surface Mined Area, cap with locally obtained soil (loess), and construct run-on and runoff surface water controls;
- Transport excavated materials via dozens of barge trips on the Kuskokwim River and dispose of the materials at a licensed disposal facility outside of Alaska;
- Conduct periodic maintenance and monitoring;
- Perform periodic monitoring of on-site groundwater quality; and
- Perform periodic sediment quality monitoring in the Kuskokwim River.

# **10.0 COMPARATIVE ANALYSIS OF ALTERNATIVES**

A comparative analysis of the remedial alternatives for Red Devil Mine is provided in the following section. The comparative analysis involves how each alternative addresses nine criteria established by the EPA to evaluate the feasibility of each site action alternative. The criteria are organized into three groups based on the function of the criteria on remedy selection:

- Threshold criteria relate to the statutory requirements that each alternative must satisfy in order to be eligible for selection. If an alternative fails either of the threshold criteria, it is not carried through the comparative analysis.
- Primary balancing criteria are the technical criteria upon which the detailed analysis is primarily based.
- Modifying criteria include state agency acceptance and community acceptance and are assessed after the public comment period for the Proposed Plan.

# **10.1** Threshold Criteria

#### 10.1.1 Overall Protection of Human Health and the Environment

Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 would achieve, by varying degrees, overall protection of human health and the environment by reducing the potential for human and wildlife exposure to elevated levels of contamination through inhalation or ingestion of tailings, waste rock, and soil. Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 would also reduce the potential for future migration of contaminated tailings, waste rock, and soil and would provide protection of groundwater. By removing Monofill #2, Alternatives SW3C, SW3D, and SW4 would provide additional protection of groundwater in the immediate area. Alternatives SW3A, SW3B, SW3C, SW3B, SW3C, SW3D, and SW4 would provide additional protection of groundwater in the immediate area. Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 also integrate ongoing monitoring to measure protection to humans and the environment. Alternative SW2 would reduce direct exposure through inhalation or ingestion but would not reduce the potential for contamination to migrate or provide protection of groundwater. Alternative SW1 – No Further Action would be the least protective of human health and the environment. Since neither Alternative SW1 nor SW2 meet the criteria for overall protection of human health and the environment, they are not carried through the comparative analysis.

#### **10.1.2 Compliance with ARARs**

Specific ARARs were identified and discussed with stakeholder agencies as part of the FS. The lead agency, BLM, considered input from stakeholders and determined the final list of ARARs by evaluating the potential cleanup activities associated with each remedial alternative and which regulatory programs would potentially apply. The specific ARARs evaluated during the FS include the State regulations, including Title 18, Chapter 75 related to oil and hazardous substance pollution control, Title 18, Chapter 60 related to solid waste management, and federal regulations in the Code of Federal Regulations (CFR) and the United States Code (USC). BLM believes Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 would comply with all associated regulatory requirements identified in Appendix A.

# **10.2** Primary Balancing Criteria

#### 10.2.1 Long-Term Effectiveness and Permanence

Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 would provide long-term, effective stabilization of contaminated materials. Alternative 4 meets the long-term protectiveness criterion slightly better than the other alternatives because all contamination in the Main Processing Area would be removed from the site and transported to a commercial disposal facility designed for the treatment and storage of this material. Alternatives SW3C and SW3D are next best at meeting this criterion since they both involve the excavation and treatment of materials contained in Monofill #2.

#### 10.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 would reduce the mobility of contaminants, and the Alternative SW3 options would achieve this reduction partially through on-site treatment (solidification of the most contaminated tailings). The solidified mine waste would be consolidated in the repository, essentially making the treatment process irreversible, and would significantly reduce the persistence, toxicity, mobility, and overall inherent hazards of these materials. None of the alternatives employ recycling or would destroy COCs because of the nature of the mine waste at the site.

#### **10.2.3 Short-Term Effectiveness**

Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 would involve relocating significant volumes of contaminated soil, tailings, and sediments and would thus present a potential for short-term exposure, primarily through windblown soil transport. The use of proven dust-control measures during the remedial action would limit the volume of materials that may be mobilized during on-site transport. Short-term risk to workers involved in the remedial action would be minimized through appropriate controls and adherence to proper health and safety protocols. For these alternatives, construction is estimated to require up to two seasons to complete, at which time protection of human health and the environment would be achieved. Alternative SW4 involves handling large volumes of waste and shipping it long distances. This increases workers' risk of physical hazards and exposure to contaminated material. Also, transporting over 200,000 cubic yards of waste long distances from the site down the Kuskokwim River and to a disposal facility outside of Alaska increases the chance of an accidental release of contaminated material. Thus, Alternative SW4 does not meet this criterion as well as Alternatives SW3A, SW3B, SW3C, and SW3D.

#### **10.2.4 Implementability**

All of the alternatives rely on proven technologies that can be readily implemented. Alternatives SW3A, SW3B, SW3C, SW3D, and SW4 present challenges as they require substantial heavy construction equipment to be mobilized to the remote site and a nearby source for low permeability cover soil would need to be identified. Alternative SW3B and SW3D would present significant long-term operational challenges related to leachate collection, storage, and management. The administrative feasibility of Alternatives SW3A, SW3B, SW3C and SW3D is generally similar because permits are unnecessary for on-site activities. Alternative SW4 would pose the most difficult implementability challenges due to the need for off-site transport of large

volumes of site wastes. Alternative SW4 would also be most difficult in terms of administrative feasibility because of the permits and coordination necessary for off-site transport and disposal.

# 10.2.5 Cost

The estimated capital cost, including both direct and indirect costs, as well as the annual operation and maintenance (O&M) costs, and the present value of capital and O&M costs for each alternative, are listed in Table 10-1.

Alternative	Capital Costs	Annual Operation and Maintenance Costs	Net Present Value of Capital and Operation and Maintenance Costs
Alternative SW1	\$0	\$0	\$0
Alternative SW2	\$816,000	\$884,000	\$1,700,000
Alternative SW3A	\$26,438,000	\$3,422,000	\$29,860,000
Alternative SW3B	\$30,998,000	\$27,212,000	\$58,210,000
Alternative SW3C	\$31,049,000	\$8,846,000	\$39,895,000
Alternative SW3D	\$32,728,000	\$27,162,000	\$58,890,000
Alternative SW4	\$198,710,000	\$1,190,000	\$199,900,000

Table 10-1	Estimated Capital. Annual Operation and Maintenance, and Net Present
Va	lue of Capital and Operation and Maintenance Costs of the Alternatives

# **10.3 Modifying Criteria**

Modifying criteria include community and State acceptance of alternatives. The BLM has considered input from the public and from federal and State agencies in response to issuance of the Proposed Plan and in developing this ROD. The BLM has met on multiple occasions with TKC, Calista, and the Georgetown Tribal Council through the RI/FS process to ensure they are updated on the project and to afford them the opportunity to comment. TKC, Calista and the Georgetown Tribal Council all provided written comments on the Proposed Plan, indicating that they do no support BLM's Preferred Alternative. The Responsiveness Summary, contained in Part III of this ROD, provides a discussion of these and other comments and the BLM's responses.

The BLM transmitted the draft Proposed Plan, including description of the preferred remediation alternative, to two state agencies for review and comment on November 4, 2019. The DNR responded to the BLM via email on December 11, 2019. The DNR's message stated that they had no comments on the draft Proposed Plan. The ADEC submitted comments on the Proposed Plan to the BLM on December 11, 2019, via email. The ADEC's message stated that they "are only commenting on the language of the PP [Proposed Plan] and not on the Preferred Alternative." The ADEC went on to state that they were working on internal approval of a verbal statement to be made during public meetings on the Proposed Plan but that they would not comment on the Preferred Alternative until they hear public comments. The ADEC project manager attended all three virtual public meetings on the Proposed Plan held in October 2020. The ADEC did not comment on the Preferred Alternative during those meetings or during the period between the community meetings and distribution of the draft ROD.

The ADEC commented on the draft ROD and the BLM responded to those comments. The two agencies resolved the responses through discussion and the draft ROD was modified per that discussion. While the ADEC did comment on specific elements of the remediation approach described in the ROD (the Preferred Alternative), the comments did not state concurrence or general disagreement with that approach.

# 11.0 PRINCIPAL THREAT WASTE

The NCP establishes an expectation that treatment will be used to address the principal threats posed by waste at a site wherever practical. A principal threat concept is applied to the characterization of "source material" at a site. Source material is material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contaminants to groundwater, surface water, or air, or acts as a source for direct exposure. The EPA has defined principal threat wastes as any source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk (e.g., a potential risk of 10<sup>-3</sup> or greater) to human health or the environment should exposure occur. Tailings/waste rock at the site represent principal threat wastes based on concentrations of antimony, arsenic, and mercury that present significant risk to humans and ecological receptors.

Based on these considerations, the BLM has incorporated treatment into several of the remedial alternatives evaluated in the FS. Under the Alternative SW3 options, treatment will involve solidification of the most highly leachable tailings prior to consolidation in the repository.

# **12.0 THE SELECTED REMEDY**

# 12.1 Summary of the Rationale for the Selected Remedy

Alternative SW3C, the Selected Remedy, satisfies the threshold criteria (see Section 10.1) and addresses the balancing criteria better than the other alternatives. In addition to being protective and complying with ARARs, the principal factors that led to selection of Alternative SW3C are:

- It is protective of human health and the environment because it eliminates the direct exposure of site waste materials to humans, fish, and wildlife.
- It is protective of groundwater because waste materials would be adequately isolated in an engineered containment structure.
- It meets all ARARs.
- It reduces toxicity and mobility of the highest-concentration tailings through treatment.
- It is constructible and more readily implemented than other alternatives given the site location and setting.
- The on-site repository central to this alternative is easily inspected and maintained and does not require developing on-site facilities needed to collect, store, and possibly treat highly concentrated contaminated fluids.
- It does not involve transportation of large volumes of contaminated materials on the Kuskokwim River or through marine waters.
- It includes monitoring and maintenance of the on-site repository and monitoring of groundwater and Kuskokwim River sediments to verify remedy effectiveness; and
- It is consistent with EPA policy on abandoned mine site cleanup strategies (EPA 2000).

Based on information currently available, the BLM believes that Alternative SW3C, which incorporates FS Supplement Alternative KR3 and components of Alternative KR5A, meets the threshold criteria and provides the most reasonable approach of all the alternatives with respect to balancing criteria.

# 12.2 Description of the Selected Remedy

The Selected Remedy includes the following elements:

- Excavating contaminated tailings/waste rock, soil, and sediments in Red Devil Creek at the site, including Monofill #2;
- Excavating nearshore sediments located downstream of the Red Devil Creek delta.
- Treatment using solidification of tailings/waste rock excavated from the Main Processing Area and Monofill #2 that fail the TCLP test for arsenic.
- Consolidating tailings, waste rock, soil and sediment into an engineered repository and disposing of materials not suitable for the repository at an appropriate facility.
- Long-term maintenance of the engineered repository and monitoring downgradient groundwater.

- Capping exposed highly mineralized areas in the Surface Mined Area.
- Long-term monitoring of groundwater in the Red Devil Creek watershed.
- Monitoring of Kuskokwim River sediments to verify remedy effectiveness; and
- Installing exclusion fencing to protect wildlife and implementing restrictions on public access and future use of the site area.

#### Tailings/Waste Rock and Monofill #2 Excavation and Consolidation

Under the Selected Remedy, the tailings/waste rock in the Main Processing Area and the contents of Monofill #2 will be excavated and consolidated into an on-site repository, located on the topographic rise northwest of the Main Processing Area.

The on-site repository location was selected because of its separation from surface water and groundwater. It is also relatively proximate to the Main Processing Area, thereby minimizing the amount of material handling and associated implementation costs. Tailings/waste rock will be excavated based on visible evidence of tailings. Once the visible contamination has been removed, the method for determining the residual on-site soil concentrations may consist of X-ray fluorescence analysis of residual soils, followed by confirmation through laboratory sampling and regression data analysis. If the residual on-site soil concentrations remain above remedial goals, the BLM will evaluate subsequent actions such as additional removal and consolidation.

Treatment using solidification of material exceeding the TCLP threshold for arsenic is proposed as part of the Selected Remedy. Selected material will be solidified ex situ by mixing excavated soil or waste with Portland cement to create a slurry, which is allowed time to cure into a solid form. The process may include the addition of pH adjustment agents, phosphates, or sulfur reagents to reduce the setting or curing time, increase the compressive strength, or reduce the leachability of contaminants. Following curing, laboratory confirmation samples for TCLP arsenic analyses will determine whether the solidified material has passed the TCLP threshold and whether additional treatment is warranted. Solidified waste passing the TCLP threshold will be consolidated in the on-site repository.

Following excavation, the Main Processing Area will be re-contoured as needed to integrate with surrounding topography. If minor amounts of backfill material are needed, an on-site borrow site will be developed. Following re-grading, the Main Processing Area will be reseeded with native plant species.

#### Kuskokwim River Sediment Removal

The Selected Remedy consists of excavating the upper 4-5 feet of the current Red Devil Creek delta and implementing monitored natural attenuation of sediments along the face and tow of the Red Devil Creek delta (Alternative KR3) Approximately 300 cubic yards of nearshore sediments currently located downstream of the Red Devil Creek delta will be dredged and incorporated into the repository. Removing the shallow river sediment is an element of Alternative KR5A will serve to reduce the environmental risk to sediment exposure.

Under the Selected Remedy, contaminated sediments and materials within the lower delta will be left in place and naturally occurring processes in the Kuskokwim River and Red Devil Creek

delta are expected to reduce the volume of contaminants at the site. Due to source reduction achieved by the implementation of the sitewide components of the Selected Remedy, the volume of in-place contaminated sediments will also be reduced. The Red Devil Creek delta and the area of contaminated sediments are located on a cut bank of the Kuskokwim River, comprising a scour environment with heavily armored bed sediments. Based on this environment, the primary recovery mechanisms are expected to be surface sediment dilution, consolidation, and bed armoring. A site-specific monitoring plan will be implemented to assess trends in contaminant reduction and trigger contingency actions, if necessary.

The Selected Remedy includes dredging approximately 300 cubic yards of contaminated nearshore Kuskokwim River sediments. A material handling area will be constructed on shore adjacent to the delta for dewatering and stockpiling dredged spoils. Long-reach excavators will be used to remove target materials within approximately 100 feet horizontally from the shore down to a depth of approximately 5 feet. Dredged spoils will be dewatered within the material handling area and allowed to passively drain. Deeper sediments will then be excavated from an anchored spud barge and temporarily loaded onto a second barge and transported to shore for offloading to a dewatering pad. Following dewatering, dredged spoils will be consolidated in the on-site repository.

#### **On-Site Repository Design**

Under the Selected Remedy, approximately 210,000 cubic yards of contaminated tailings/waste rock, contaminated soil, delta material, Monofill #2 contents, Red Devil Creek sediment, and nearshore Kuskokwim River sediments will be excavated and consolidated in an on-site repository. An impermeable geomembrane cover system was selected for the proposed repository based on its ability to reduce the potential for surface water infiltration. A bottom liner system was excluded from the repository design because the cover will be designed to provide adequate protection from water infiltration. By limiting water flow through the waste, leachate generation is expected to be minimal, negating the need for a collection system and associated maintenance.

This on-site repository will be constructed in the westernmost portion of the Surface Mined Area and will encompass approximately 5 acres (see Figure 9-1). Haul roads will be constructed from the excavation areas, including the borrow areas, to the repository location. The repository will be constructed by preparing and compacting the base soils within the footprint of the repository, placing tailings and contaminated sediment material in 2-foot lifts, and compacting them in accordance with the final design documents. Starting at the repository base and working upward, the repository layers will be: fill material (i.e., tailings, soil, and solidified material), excavated sediments, loess, geomembrane, geotextile, and, finally a layer of soil suitable to support vegetative growth. Side slopes will have a maximum slope of 2.5H:1V, and the top of the repository will be graded at 3 percent to promote drainage.

To limit infiltration into the repository from precipitation and snow melt, the cover system will consist of a protective geotextile underlay and geomembrane placed over the contaminated material and overlain with 18 inches of cover soil. Vegetation will then be established on the cover soils to protect against erosion. The cover is assumed to be a 60-mil (0.06-inch) reinforced polyvinyl chloride geomembrane. The geotextile and geomembrane will be secured in an anchor

trench design to account for solifluction. The geotextile will be installed above the geomembrane liner and will act to stabilize the cover soils; provide drainage through the cover system; and serve as a cushion between the cover soils and the geomembrane, protecting the geomembrane from tearing or puncturing during construction of the repository.

During grading of the on-site repository, drainage ditches will be constructed along the upgradient perimeters to intercept surface water flow and direct it around the repository. The ditches should be constructed in native soil. Rock armoring or other energy-diffusing best management practices will be installed at the ditch discharge locations.

Drainage controls, including those for the engineered covers over the mine waste piles, should accommodate, at a minimum, a 25-year, 24-hour storm event. The discharge locations of the drainage pathways will utilize energy dissipation methods to control erosion at the discharge location.

Temporary erosion and sediment controls will be implemented during excavation activities. These controls could include silt fencing and hay bales strategically placed to prevent the off-site migration of site sediments, and leachable contaminants.

O&M will consist of annual inspections of the repository cover system for indications of erosion, instability, or damage. Repairs will be performed on an as-needed basis. The cover systems will be inspected during the spring thaw when melting ice and snow produce maximum seasonal runoff, as this is the time period when erosion and instability are likely to occur and could lead to off-site migration of contaminated material. Low permeability caps will be checked semiannually for the first three years. Run-on and runoff controls will be inspected annually for erosion, blockage, or unexpected drainage patterns at the release site and repaired, maintained, or replaced on an as-needed basis. Additionally, while the repository is considered to be the final remedy, five-year reviews will be conducted until it is determined they are no longer necessary. The BLM will make decisions about needed repairs or future actions at the time of five-year reviews in consultation with agency stakeholders.

In addition to O&M associated with maintaining the cover systems, groundwater monitoring will be performed. BLM will establish a baseline groundwater monitoring network downgradient of the repository and in the Red Devil Creek watershed area once the remedy construction is complete.

#### Fencing and Institutional Controls

The Selected Remedy will enhance and make use of the existing fence/gate and warning signs installed around the perimeter of the site to exclude humans and wildlife from exposure to contaminated materials. Annual inspection of fencing and signs will be conducted, as well as repairs and replacement if needed.

#### 12.3 Expected Outcome of the Selected Remedy

The Selected Remedy will provide long-term, effective isolation and stabilization of contaminated materials and reduce actual and potential human and ecological exposure to tailings, waste rock, and soil containing arsenic, antimony, mercury, and other heavy metals at

concentrations that exceed remedial goals. Human exposure to hazardous substances within the Main Processing Area will be reduced by using ICs, removing and consolidating contaminated materials in the on-site repository, and preventing or minimizing migration of COCs by using stormwater controls and recontouring excavated areas.

The Selected Remedy will relocate significant volumes of contaminated soil and tailings/waste rock and will thus present a potential for short-term exposure, primarily through windblown soil transport. In addition, during dredging operations of Red Devil Creek and the Kuskokwim River, contaminated sediments may become mobilized and migrate downstream, which may present a limited short-term risk to the local population. Using proven dust control and sediment dredging controls during the remedial action will limit the volume of materials that may migrate. Short-term risk to workers involved in the remedial action will be minimized through appropriate controls and adherence to proper health and safety protocols.

# **13.0 STATUTORY DETERMINATIONS**

## **13.1** Protection of Human Health and the Environment

The Selected Remedy will achieve this primary objective by reducing the potential for human and wildlife exposure to elevated levels of contamination through inhalation or ingestion of tailings, waste rock, soil, and sediment. The Selected Remedy will also reduce the potential for future migration of contaminated tailings, waste rock, and soil; and will provide increased protection of groundwater in the area of Monofill #2. The Selected Remedy will also integrate ongoing monitoring to measure protection of human health and the environment.

#### 13.2 Compliance with Applicable or Relevant and Appropriate Requirements

CERCLA includes a process that is defined in federal regulations for investigating and cleaning up sites like the Red Devil Mine. The CERCLA process recognized that other state and local regulations may apply and must be considered in evaluating cleanup alternatives. The BLM evaluated and identified a number of federal regulations in the CFR and USC, and a number of state regulations. The majority of the state regulations considered by the BLM are included in 18 AAC 75 and relate to oil and hazardous substance pollution control. The BLM also reviewed regulations in 18 AAC 60 that relate to solid waste management. The majority of the state regulations included in the BLM's review were accepted as applicable to Red Devil Mine. The Selected Remedy will comply with all ARARs.

#### 13.3 Cost-Effectiveness

The Selected Remedy has a higher capital cost and present worth cost than other alternatives, however the Selected Remedy provides far greater protection of human health and the environment. In addition, the Selected Remedy is only slightly more than half the cost of installing a liner and managing leachate and provides greater protection than simple ICs. Finally, the Selected Remedy is significantly less expensive than removing all contamination from the site and shipping it outside of Alaska for disposal.

#### **13.4** Use of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable

The Selected Remedy will provide long-term isolation and stabilization of waste materials to minimize potential for future contaminant migration from the site. The Selected Remedy incorporates treatment of the most contaminated materials to further reduce potential contaminant mobility.

#### **13.5** Preference for Treatment as a Principal Element

Alternatives SW3A, SW3B, SW3C, and SW3D utilize treatment as a component of the remedy. In the Selected Remedy, tailings that fail the TCLP test for arsenic will be treated through solidification prior to consolidation with other tailings/waste rock in the on-site repository. Thus, the Selected Remedy satisfies the preference for treatment as a principal element. None of the other alternatives incorporate treatment as an element of the remedy.

#### 13.6 Five-Year Review Requirements

Because the Selected Remedy will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the BLM will conduct a review of the performance of the remedy, pursuant to CERCLA Section 121(c) and NCP Section 300.430(f)(4)(ii), no less often than every five years after initiation the Selected Remedy to ensure that the remedy remains protective of human health and the environment.
# 14.0 DOCUMENTATION OF SIGNIFICANT CHANGES FROM THE PREFERRED ALTERNATIVE IN THE PROPOSED PLAN

The Selected Remedy does not incorporate any significant changes from the Preferred Alternative presented in the Proposed Plan.

#### REFERENCES

Alaska Department of Environmental Conservation (ADEC) 2018. Procedures for Calculating Cumulative Risk. Division of Spill Prevention and Response, Contaminated Sites Program. February 1.

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### PART III – RESPONSIVENESS SUMMARY

#### **INTRODUCTION**

This Responsiveness Summary section of the ROD summarizes and responds to public comments on the Proposed Plan for the Red Devil Mine, which were received during the public comment period on the preferred remedial action at the site. The Responsiveness Summary was prepared in accordance with the requirements of Section 117 of the CERCLA, as amended, 40 Code of Federal Regulations Section 300.430(f)(3)(i)(F) of the NCP, and the Community Involvement Plan for the Red Devil Mine.

Pursuant to its lead agency authority under CERCLA, the BLM issued a Proposed Plan for public review on February 4, 2020, identifying its Preferred Alternative to address the release and threatened release of hazardous substances at or from the Red Devil Mine. The Proposed Plan was placed in the administrative record distributed via Certified Mail on February 4, 2020 to 36 tribes, local governments, and Alaska Native Corporations in the middle Kuskokwim River region. The Proposed Plan was also distributed to the EPA, Region 10, the ADEC, the DNR.

Pursuant to NCP Section 300.430(f)(3)(i)(C), a 30-day public comment period on the Proposed Plan began on March 1, 2020. Ten public meetings were scheduled for March and April 2020. Those meetings were postponed on March 16 due to the onset of the COVID-19 pandemic. In a letter to the BLM on April 15, 2020, the Calista Corporation requested an extension of the comment period. The BLM extended the comment period for the Proposed Plan through December 18, 2020. The public meetings originally scheduled for March and April were held virtually in October 2020.

On Sept. 17, 2020, the BLM sent certified letters to the 36 tribes, local governments, and Alaska Native Corporations notifying them of the opportunity to participate in the virtual public meetings. The letters included the link to the BLM's Red Devil Mine web page, where participants could find links to the virtual public meetings, the meeting presentations, the Proposed Plan, and the administrative record. Toll-free conference lines were established as an alternative for those with limited internet access to participate in the virtual meetings. The letter also invited communities to suggest additional meeting dates. In addition, postcards with the meeting dates and the link to the BLM's Red Devil Mine web page were mailed to the 316 recipients of the Red Devil Mine newsletter.

In early October, meeting flyers and hard copies of the presentations were sent to each of the 36 organizations. Because the village of Red Devil has limited internet access, hard copies of the Proposed Plan and the meeting presentations were mailed to each Red Devil post office boxholder. In accordance with the NCP, the Notice of Availability of the administrative record was published on October 7, 14, and 21 in *The Delta Discovery*, a newspaper of general circulation printed and published weekly in Bethel, Alaska. The ads included the virtual meeting dates, times, and links, as well as the BLM Red Devil Mine web page with the Proposed Plan, meeting presentations, and administrative record.

Virtual meetings were conducted on October 20, 22, 27, and 29, 2020, to present the Proposed Plan and solicit oral and written comments on the Proposed Plan from interested parties. A total of 16 people attended the virtual public meetings, including four representatives of contracting or consulting firms and four representatives of the BLM. The BLM representatives explained the Preferred Alternative and other alternatives under consideration and answered questions from the public.

The administrative record for the Selected Remedy, which is located at the BLM's State Office at 222 W 7<sup>th</sup> Avenue in Anchorage, contains copies of the Proposed Plan, public comments received regarding the Proposed Plan, and technical reports and other documents upon which the ROD is based, including the RI and FS.

This Responsiveness Summary serves two functions:

- 1. Summarizing the public comments received on the Proposed Plan and the remedial alternatives described therein; and
- 2. Presenting the BLM's evaluation of and response to those public comments as it finalized the remedy selection process presented in this ROD.

#### SUMMARY OF AND RESPONSE TO SIGNIFICANT COMMENTS

Written comments on the Proposed Plan were received from the Calista Corporation, TKC, the Georgetown Tribal Council (GTC), and private citizens. These comments are available for review in the administrative record.

Comments have been organized into the following categories:

- Environmental Impacts from Cleanup Activities;
- Groundwater; and
- Selected Cleanup Alternative.

A number of substantive comments were received during the public comment period; these are summarized by topic in the following paragraphs, along with the BLM's responses. In addition, a comprehensive list of individual comments and the BLM's responses is presented in a table in the Comments and Responses section following this introduction. The comments presented in this Responsive Summary have been considered in the BLM's final determination of the Selected Remedy presented in this ROD.

#### **Environmental Impacts**

One comment was submitted regarding the lack of discussion of unintended adverse environmental impacts to the Kuskokwim River that would result from sediment excavation activities. The commenter also inquired if there was heightened risk of mobilizing contaminants during excavation activities.

The dredging of sediment in Red Devil Creek may cause contaminants to mobilize and migrate downstream, which may present a limited short-term risk to the local fish population. The risk to

the local fish population is anticipated to be minimal and is described in the decision summary section of the ROD (Section II).

#### Groundwater

A number of comments were received regarding groundwater contamination and the selection of ARARs with respect to the proposed alternatives. One comment inquired if a background concentration could be established prior to removal of the tailings, and the other inquired whether the Preferred Alternative meets federal and state established ARARs. One comment questioned potential impacts to a nearby domestic drinking water well.

Groundwater in this area recharges at higher elevations and flows downward to the creek, with some portion flowing directly into the Kuskokwim River. The groundwater flows through a complex network of fractures. As it moves through the bedrock, it interacts with the aquifer, and naturally occurring minerals in the bedrock dissolve (very slowly) into the water. The fractures are not always well connected, and natural mineralization is not evenly spread throughout the watershed, creating conditions that promote variable groundwater concentrations. Groundwater that comes into contact with mineralized bedrock contains higher contaminant concentrations than groundwater that is not in contact with mineralized bedrock. Investigation results demonstrate that the combination of poorly connected fractures and localized mineralization creates some areas where groundwater concentrations are elevated and others where concentrations are more than an order of magnitude lower.

Investigation results demonstrate that tailings influence groundwater concentrations in the lower watershed. The tailings generally increase groundwater concentrations more than the mineralization, inhibiting understanding of natural groundwater concentrations near Red Devil Creek where tailings have accumulated. Consequently, it is technically infeasible to estimate a single background concentration for all three COCs. In keeping with the CERCLA process, remedial goals were identified for all three COCs and are listed in Table 2-4 of the FS Supplement. The accompanying notes pertaining to Remedial Action Objective (RAO) Conformity for arsenic and antimony reflects the high level of uncertainty in the selected remedial goals. The remedial goal for mercury was selected based on applicable regulatory criteria rather than background concentrations.

Once tailings are removed, they will no longer influence groundwater concentrations. As groundwater continues to flow through the excavated area, concentrations will decrease as the impacts of tailings diminish. Over time, groundwater concentrations will come to reflect natural conditions throughout the watershed, including the lower elevations near Red Devil Creek.

As discussed above, the variability in COC concentrations created by fractured flow and localized mineralization make it infeasible to calculate a single background concentration for each contaminant. Therefore, the RAO is to eliminate the influence of tailings on the groundwater and allow concentrations to return to a level defined by natural conditions. These levels are expected to be similar to levels presently observed in bedrock in the upper part of the watershed, which were used to develop groundwater remedial goals, presented in the FS Supplement. Because it is not feasible to define the separate impacts of natural mineralization and tailings on groundwater concentrations at this time, the BLM will develop long-term

groundwater quality objectives based on post-remediation conditions and background water quality. Long-term monitoring data will be summarized and reviewed every five years as required under CERCLA. Each five-year review will be performed in coordination with the ADEC and DNR.

The observed variability in existing groundwater concentrations also makes it technically impracticable to meet the chemical-specific ARARs (specifically, Safe Drinking Water Act, Alaska Water Quality Standards, and Clean Water Act). After the Remedial Action is performed, the BLM will establish institutional controls to ensure the adequacy of groundwater protection at the site in coordination with the ADEC and DNR.

TKC noted that the Proposed Plan does not address the use of domestic drinking water wells in the vicinity of the site and the waste storage area. A groundwater detection monitoring system will be established and will include monitoring wells that are hydrologically downgradient of the repository, including locations generally north and northwest of the repository, east and northeast of the repository, and south and southeast of the repository.

#### **Selected Cleanup Alternatives**

Several comments addressed the selected cleanup alternatives. Many of these included questions pertaining to the effectiveness of and selection criteria for a liner in Alternatives SW3B, SW3C, and SW3D. Other commenters expressed concerns regarding the Preferred Alternative in relation to the spread of mine waste contamination and asked whether the Preferred Alternative is the best alternative to address tribal concerns and needs.

The BLM has engaged TKC since 2014 and provided them with information regarding project activities, the results of data collection, and the selection of the Preferred Alternative. Prior to making the Proposed Plan available to the public, the BLM met with TKC leadership to discuss the Preferred Alternative. TKC was given the opportunity to provide feedback on the Preferred Alternative. This discussion built on previous discussions, with the objective of providing TKC with a detailed and complete understanding of the risk posed by contaminants at the site and the rationale for the cleanup approach and selection of the Preferred Alternative.

TKC also inquired about the lack of a leachate liner under the Preferred Alternative and asked if cost was a major consideration in the selection of the Preferred Alternative. They also inquired why Alternatives SW3B and SW3D only received moderately favorable ratings. Additionally, the GTC stated that they Preferred Alternative SW4 because it is the only alternative that would remove all the waste and provide a permanent solution to protect residents near the Kuskokwim River.

Cost is one of the nine criteria established by the EPA to assess the feasibility of cleanup actions under CERCLA. Compliance with regulations and overall protection are the two most important criteria. Cost is a secondary criterion to other criteria such as consistency with applicable regulations and effective protection of human health and the environment. The detailed hydrologic analysis of the proposed repository and the effectiveness of the cap system demonstrated that it met the requirements for overall protection. Alternative SW3B leaves the existing monofill in place. Alternatives SW3B and SW3D were assigned "least favorable" status

due to the significant increase in operations and maintenance requirements compared to the other alternatives and because of the significant increase in cost associated with these alternatives. Alternative SW3C also avoids the risks associated with transporting over 200,000 cubic yards of high-concentration materials hundreds of miles down the Kuskokwim River and thousands of miles to a facility on the Columbia River in Oregon, which would increase the potential for an accidental release.

The GTC letter raised the concern that implementation of the Preferred Alternative would spread contamination. It also expressed concerns regarding the potential for runoff water to penetrate the repository, and an accidental catastrophic failure of the repository. The BLM believes that the protective measures that would be implemented under the Preferred Alternative would effectively limit the potential migration of site contaminants. The repository includes an engineered cap with measures to divert surface runoff and prevents groundwater from directly contacting the contents of the repository. In addition, the BLM performed a ground surface stability analysis to confirm that the structure is designed to withstand a seismic event. Finally, it is noteworthy that the repository will be located 300 feet above the Kuskokwim River, and the U.S. Geological Survey (USGS) records, dating back to 1964, indicate maximum flood events are less than 30 feet.

The GTC also expressed concern that the Preferred Alternative is not in the best interest of the Georgetown tribal members and residents near the Kuskokwim River. The BLM has compiled extensive data on the conditions at the site and performed a detailed analysis of the proposed repository design. The results of these investigations indicate that groundwater at the site will continue to contain elevated levels of COCs due to the presence of naturally occurring mineralization (see the Groundwater section, above). The results of the hydrologic analysis indicate that the consolidation under the cap is protective of human health and the environment. The BLM will segregate the tailings that demonstrate the greatest potential to leach high concentrations of metals; these will be treated by solidification with Portland cement prior to consolidation in the repository, which will prevent water from leaching metals.

TKC requested the total volumes of material to be excavated based on the various alternatives. A technical memorandum outlining the estimated volumes is available in the project's administrative record.

Finally, TKC requested a more detailed description of the Monofill #2 geomembrane. "Geomembrane" is a general term for several different products that are composed of either plastic or rubber and are impermeable to water. However, under the Preferred Alternative, Monofill #2 would be deconstructed and the associated tailings would be consolidated into the on-site repository. The building material, old processing equipment, and Hypalon cap (currently in Monofill #2) would be transported off site for disposal.

The following tables include comments received at the public meetings or during the public comment period. Oral comments are summarized or paraphrased, and written comments are included verbatim as they were received. The complete set of comment letters is available in the administrative record for the Red Devil Mine at

<u>https://www.ak.blm.gov/red\_devil\_mine/Red\_Devil\_Mine\_Admin\_Record.html</u> and at the BLM's Anchorage Field Office:

Bureau of Land Management – Anchorage Field Office 4700 BLM Road Anchorage, AK 99507 (907) 267-1246 Hours: Monday–Friday, 7:30 a.m. to 4:00 p.m.

### **COMMENTS & RESPONSES**

### **Table A Environmental Impacts**

TABLE A. ENVIRONMENTAL IMPACTS				
Comment Number	Organization	Comment	BLM Response	
1	ТКС	There is no discussion in the text regarding the potential for unintended adverse environmental impact to the Kuskokwim River as a result of planned sediment excavation activities at the mouth of Red Devil Creek. It is appreciated that the intent is to remove this source of contamination from the shore environment, but is there not a heightened risk of mobilizing contaminants in the process and potentially impacting fish populations? This is worth addressing at least in summary form for this Proposed Plan.	FS Supplement Sections 4.3.4.5 and 4.3.5.5, which address the short-term effectiveness of Kuskokwim River Alternatives KR4a and KR4b, respectively, note that "during dredging operations, contaminated sediments may become mobilized and migrate downstream, which may present a limited short-term risk associated with the local population." It is expected that such potential short-term mobilization of contaminants would result in a limited risk for fish populations. This potential limited short- term risk is described in the decision summary section of the ROD (Section II).	

#### **Table B Groundwater**

TABLE B. GROUNDWATER				
Comment Number	Organization	Comment	BLM Response	
2	ТКС	Pg. 12 – The first sentence states "Groundwater COC concentrations in the area near Red Devil Creek are strongly influenced by the presence of tailings and waste rock", implying elevated concentrations of COC's relative to background conditions. However later the statement is made "it is reasonable to assume that concentrations of COCs in groundwater after excavation would be similar to those observed in bedrock in the upper elevations of the watershed". It is not understood how it reasonable to assume COCs would return to baseline conditions in an impacted section of the watershed. The summary goal is vague that "the BLM will develop long-term groundwater quality objectives based on post-remediation conditions and background water quality data". Why can't these be established now, pre- excavation? Can naturally occurring conditions be established as the goal? Table 2 provides some limited Groundwater Remedial Goals which seems to contradict the above statement that objectives will be established in the future.	A detailed discussion of background groundwater concentrations is contained in Section 2.3.3.2.1 of the FS Supplement. While the discussion in Section 2.3.3.2.1 is thorough, it is quite technical. There are several questions within the comment that build toward the larger question of why background concentrations cannot be established before tailings are removed from their current location along lower Red Devil Creek. The response below addresses specific elements of the comment in an attempt to clarify the discussion in Section 2.3.3.2.1. To understand groundwater conditions in the Red Devil Creek watershed, it is important to know that the groundwater is recharged in upper elevations (surrounding hills and ridges) and discharges into Red Devil Creek. COC concentrations in groundwater are highly variable throughout the watershed due to complex fracture flow patterns and the influence of natural mineralization. The tailings piles near Red Devil Creek exert considerable influence on groundwater concentrations in the lower watershed, making it impossible to estimate natural background concentrations in this area. Once tailings are removed, their influence on	

TABLE B. GROUNDWATER			
Comment Number	Organization	Comment	BLM Response
			groundwater concentrations will decrease and water from the upper watershed will flush through to the creek. Over time, groundwater concentrations will come to reflect natural conditions in the watershed. These natural levels are expected to approximate levels presently observed in bedrock in the upper part of the watershed, which were used to develop groundwater remedial goals presented in the FS Supplement. Therefore, the RAO is to eliminate the influence of tailings on the groundwater and allow concentrations to return to a level defined by natural conditions. Because it is not possible to estimate background conditions in the lower watershed at present, long-term monitoring data will be reviewed through the 5-Year Review process to ensure that remedial goals accurately reflect natural conditions throughout the watershed. The 5-Year Review process is performed in coordination with the ADEC and DNR.
3	ТКС	Alternative SW3C is stated on pg. 20 as meeting Applicable or Relevant and Appropriate Requirements (ARAR's). However, it is not clear that ARAR's will be met for groundwater quality, as previously discussed on pg. 12. The text on that page again states that the BLM will, in the future, "develop long-term groundwater quality objectives". This does not appear	Proposed Plan pages 19–20, Section 2, Compliance with Other Regulations, states that "Alternatives SW3C, SW3D, and SW4 would comply with <u>all associated regulatory</u> <u>requirements</u> ." Alternative SW3C incorporates groundwater alternative GW2. It is stated in FS Supplement Section 4.2.2.2, Compliance with ARARs, that "compliance with chemical-specific

TABLE B. GROUNDWATER				
Comment Number	Organization	Comment	BLM Response	
		consistent with ARAR's, which are defined on pg. 19 as presumably quantitative applicable federal and state statutes, regulations and other requirements. Is it the justified waiver that would be used to fulfill ARAR's?	ARARs would not be achieved—specifically, the Safe Drinking Water Act, Alaska Water Quality Standards, and Clean Water Act Water Quality Standards. It should be noted that under all alternatives, cleanup to chemical-specific ARARs is not achievable at the Site due to the influence of naturally occurring mineralization, and the final cleanup action will require that Institutional Controls be required."	
4	TKC	On pg. 22 it is not clear how the selected alternative would be protective of groundwater because the excavated materials would be "adequately isolated". Without a liner the materials are only partially isolated. The plan for long-term monitoring without pre-established COC goals for groundwater concentrations does not appear to meet the goal of being protective of groundwater.	The BLM's assessment that the excavated materials would be adequately isolated from groundwater (by a cap and run-on controls) is based on results of the Final Technical Memorandum - Red Devil Mine Proposed Repository, Refined Hydrologic Analysis. The following summary of the analysis is presented on page 8 of the Proposed Plan: "The results of the refined analysis show that for all COCs, the concentrations in leachate decrease from the initial leachate concentrations to levels below State of Alaska drinking water criteria within the unsaturated zone at depths of less than 4 feet below the base of the repository." Total depths to groundwater in the area of the proposed repository are greater than 20 feet. The ADEC agreed with the analysis provided in this document. Although the EPA divested itself from the Red Devil CERCLA project before this	

TABLE B. GROUNDWATER				
Comment Number	Organization	Comment	BLM Response	
			document was complete, they provided technical input on the overall concepts and draft versions of the document. Remedial goals for groundwater are listed in Table 2-4 of the FS Supplement Report. As discussed in the introduction of this document, the long-term monitoring data will be compiled and formally reviewed every five years in coordination with the ADEC and DNR to ensure they accurately reflect watershed conditions.	
5	ТКС	The plan does not address the impacts of the groundwater in direct relation to the existing population that is currently using individual wells near the mine site and the waste storage site. The closest individual lives approximately ½ mile downhill from the proposed waste storage site. The resident has been living at that location full time for over 40 years and utilizes an individual well for water. The Proposed Plan does not address impacts to the immediate population near the site.	Under sitewide Alternative SW3, a groundwater detection monitoring network will be established to evaluate the protectiveness of the on-site repository. This network will include monitoring wells that are positioned at locations hydrologically downgradient of the repository, including locations generally to the north and northwest of the repository (between the repository and the McCally Creek drainage), east and northeast of the repository (between the repository and the Kuskokwim River), and south and southeast of the repository (between the repository and the Red Devil Creek drainage). Additionally, based on distance and the groundwater flow regime at the site, the BLM does not consider the nearest residential well to be threatened by site contamination.	

### Table C Selected Cleanup Alternatives

TABLE C. SELECTED CLEANUP ALTERNATIVES				
Comment Number	Organization	Comment	BLM Response	
6	Calista Corporation	First, to the extent that one our regional stakeholders and partners, The Kuskokwim Corporation ("TKC"), raises substantive concerns about the Preferred Alternative, Alternative SW3C, we ask that BLM take any additional time needed to address those concerns before finalizing the Proposed Plan.	The BLM has proactively engaged TKC through multiple phases of the project, extending back to 2014. Through multiple tribal consultation meetings, TKC leadership has been informed of project activities and the results of data collection and analysis leading up to the selection of a preferred remediation alternative. Prior to making the Proposed Plan available to the public, the BLM met with TKC leadership to discuss the Preferred Alternative. The BLM's objective in consulting with TKC at that time was to describe the Preferred Alternative and the analysis used to identify that alternative. Further, it was an opportunity for TKC to provide feedback. That discussion built on previous discussions from earlier phases of the project, with the overall objective of providing TKC with a detailed and complete understanding of the risks posed by site contaminants and the rationale for the cleanup approach defined under the Preferred Alternative.	

TABLE C. SELECTED CLEANUP ALTERNATIVES				
Comment Number	Organization	Comment	BLM Response	
			about whether the action defined under the Preferred Alternative will provide sufficient protection of human health and the environment, which is a primary feasibility criterion established by the EPA as part of the RI/FS elements of the process applied to the Red Devil Mine. Several comments address other specific feasibility criteria. There are nine criteria, seven of which were used to identify the Preferred Alternative. Figure 4 in the Proposed Plan illustrates how each alternative was rated relative to seven criteria. Only Alternatives SW3C and SW4 meet the requirements for the two most important criteria—regulatory compliance and overall protection. Alternative SW3C best meets the requirements of the other five criteria, and so it was designated as the Preferred Alternative. Elements of the Preferred Alternative it was designated as the Preferred Alternative. Elements of the Preferred Alternative identified by TKC in their comments are discussed in the responses that follow.	
7	Calista Corporation	Second, due to the COVID-19 pandemic, we believe that the comment period should be extended beyond April 30, 2020. Adequate time should be allocated for BLM to conduct public outreach in Kuskokwim River communities before the Preferred Alternative is finalized. Unfortunately, all of the public meetings previously scheduled by BLM in March and	The BLM extended the comment period for the Proposed Plan through December 18, 2020. The public meetings originally scheduled for March 2020 were held virtually in October 2020.	

TABLE C. SELECTED CLEANUP ALTERNATIVES				
Comment Number	Organization	Comment	BLM Response	
		April were postponed due to COVID -19-related travel restrictions and public health precautions.		
8	ТКС	Pg. 20 suggests that Alternatives SW3B and SW3D, which includes a bottom liner and a leachate collection system, would present "significant long-term operational challenges related to leachate collection, storage and management". However, these challenges are not identified or described so it is not clear why this option is identified as rating low for implementation ability. Overall liners are commonly used at landfills, mining operations, and other solution recovery operations. The challenges appear more related to cost than implementation ability. It is appreciated that the alternatives include transportation of collected leachate off site. Is this the driving challenge? There is no discussion here of the potential for on-site management.	Operational challenges associated with collection, storage, and management of leachate are described in FS Section 3.2.3.2, Alternative 3b – Excavation of Solids and Sediments, Solidification, Onsite Consolidation, Capping, and Collection and Offsite Disposal of Leachate. In addition to transportation of collected leachate, other operational challenges are described in the section as follows: "In addition to the Operation and Maintenance (O&M) requirements presented for Alternative 3a, evaluation of the leachate collection system and the bottom liner would be required annually to assess whether damage to the bottom liner had occurred, clogs exist in the collection piping, sump and pipeline operational issues are occurring, or repairs are needed. Repairs would be performed on an as-needed basis. The system should be inspected during the spring thaw when melting ice and snow produce maximum seasonal runoff, as this is the time period when infiltration potential will be highest."	

TABLE C. SELECTED CLEANUP ALTERNATIVES				
Comment Number	Organization	Comment	BLM Response	
			overall protection are the two most important of the nine criteria. Had the detailed hydrologic analysis of the proposed repository not demonstrated that the cap system effectively prevents leachate impacts to groundwater, Alternative SW3C would not have met the requirement for overall protection and would not have been selected as preferred.	
9	ТКС	It is not understood why Alternative SW3C has received a "most favorable" criterion rating for Long-Term Effectiveness, whereas Alternatives SW3B and SW3D are only moderately favorable. Having a liner in place ensures no long-term seepage into the groundwater system which is hydrologically connected to the Kuskokwim River. Also the Implementability evaluations are assign a "least favorable" criterion to Alternatives SW3B and SW3D which drives the overall selection of the cheaper Alternative SW3C. Lastly cost for all SW3 options are listed as "moderately favorable" despite the SW3B and SW3D options being twice as expensive as the selected preferred SW3C option. The Proposed Plan reads like cost is a driving factor to the Preferred Alternative decision, although it is not identified as such in Figure 4.	Regarding long-term effectiveness, Alternative SW3D was assigned "most favorable" for long- term effectiveness, the same as Alternative SW3C. Alternative SW3B was assigned "moderately favorable" because, unlike Alternatives SW3C and SW3D, it leaves the existing monofill in place. Regarding implementability, Alternatives SW3B and SW3D were assigned "least favorable" for implementability due to significantly increased operations and maintenance requirements compared to the other alternatives. Regarding cost, the assignments for cost favorability reflect order of magnitude cost ranges.	

TABLE C. SELECTED CLEANUP ALTERNATIVES				
Comment Number	Organization	Comment	BLM Response	
10	TKC	It would be helpful to have a summary table of total volumes of material to be excavated under the various evaluated scenarios. For example, it is not stated what total volumes of materials will be excavated for the SW3 scenarios including Red Devil Creek sediments and sediments at the Kuskokwim River mouth. It is stated that 940 yd <sup>3</sup> of material will be excavated from the Monofill #2 and 1,700 yd3 of old tailings.	The total estimated volume of material to be excavated varies depending on the SW3 option (A through D). An updated estimate of volumes of materials to be excavated in individual areas of the site is provided in the Final Technical Memorandum - Red Devil Mine Proposed Repository, Refined Hydrologic Analysis. This tech memo is part of the online project administrative record. The estimated volumes of materials to be excavated under the various evaluated sitewide remedial alternatives are cited in the ROD.	
11	ТКС	The description of the cover system for Monofill #2 is "geomembrane". Can this be further described? The follow-on text states that it will "inhibit" leaching – does this mean it will be semi-impermeable? It would be helpful to have more of a description of the geomembrane.	"Geomembrane" is a general term for several different products that are all constructed of either a form of plastic or rubber compound. The important characteristic for this application is that the material is essentially impermeable to water. The material is manufactured in sheets that are welded together when installed as a cap such as the one specified for Monofill # 2 in Alternatives SW3A and SW3B. It should be noted that under the Preferred Alternative, SW3C, Monofill #2 will be deconstructed and the tailings associated with this monofill will be consolidated into the on-site repository. The building material, old processing equipment, and Hypalon cap currently incorporated into Monofill #2 would be transported off site for disposal.	

TABLE C. SELECTED CLEANUP ALTERNATIVES			
Comment Number	Organization	Comment	BLM Response
			A description of the cover system that would be constructed for Monofill #2 is described in Section 3.2.3.1 of the Final FS (E & E 2016). The FS completed in 2016 is available via the online project administrative record.
12	GTC	While the GTC is pleased to see progress move forward on a plan to remediate RDM, the GTC also has some reservations concerning the Bureau of Land Management's Preferred Alternative. Residents of Red Devil who are Tribal members of the NVG are also concerned with the mine waste at RDM. They are concerned that any action at the mine will further the spread of toxic material due to the remedial work at RDM.	The BLM recognizes the importance of the potential for spreading of contamination as a result of the remedial activities. The BLM believes that the protective measures that would be taken during implementation of Alternative SW3 (including dust control) would effectively limit the potential migration of contaminants.
13	GTC	Respectfully, the Georgetown Tribal Council remains unconvinced that the BLM's Preferred Alternative is the best alternative for Georgetown's tribal members in the area and residents of the Kuskokwim River. The GTC is concerned that if the mine waste is interred at RDM instead of removed, the waste will continue to pose a threat to human health and the environment.	The BLM appreciates and shares the GTC's concern for the wellbeing of local residents. The detailed analysis of groundwater at the mine site demonstrates that groundwater migrating into the Kuskokwim River from the mine site, even in its current state, presents no measurable impact on the Kuskokwim River. This conclusion is supported by the results of extensive sediment sampling in the river and results of fish tissue analysis. Regarding the Preferred Alternative, which includes consolidation of tailings and waste rock in an on-site repository, the BLM has compiled

TABLE C. S	TABLE C. SELECTED CLEANUP ALTERNATIVES			
Comment Number	Organization	Comment	BLM Response	
			extensive data on-site conditions and performed detailed analysis of the proposed repository design. Investigation results clearly show that groundwater at the Red Devil Mine will contain elevated COC concentrations regardless of any action taken, due to the presence of naturally occurring mineralization. The detailed hydrologic analysis of the proposed repository demonstrates that on-site consolidation under the cap, as designed, is protective of human health and the environment. The BLM is committed to regular operation and maintenance of the repository to ensure that the repository continues to prevent adverse environmental impacts. The sitewide remedy will undergo a five-year review to assess its effectiveness, and the BLM will work with federal and state stakeholders to monitor remedy performance on a regular basis. As an additional protective measure, the BLM intends to segregate tailings that demonstrate the greatest potential to leach high concentrations of metals. The segregated tailings will be treated by solidification prior to incorporation into the repository. Solidification is process that coats the tailings with Portlend agment which prevents	
			water from leaching metals.	

TABLE C. SELECTED CLEANUP ALTERNATIVES						
Comment Number	Organization	Comment	BLM Response			
14	GTC	The Native Village of Georgetown is concerned that interring the mine waste will lead to an unnecessary risk of exposure in the future. The risks that the GTC are most concerned with is the potential for runoff water to penetrate the repository, and the risk of an accidental catastrophic failure of the repository in the long term.	Water infiltrating through the cap and catastrophic failure of the repository are two very different issues, explained below: As discussed in the response to comment 13, the BLM has conducted detailed analysis of the cap's ability to prevent infiltration, and the results of that analysis indicate that the cap, as designed, is effective in both the short and long term in preventing measurable infiltration of rainfall and snowmelt. The BLM will regularly monitor the cap to ensure that it remains in good working order. The repository is a large pile of earthen material with an engineered cap that includes measures to divert surface runoff and prevent groundwater from directly contacting the repository contents. The BLM has also performed a slope stability study of the ground surface beneath the repository to confirm that the designed structure will withstand a seismic event. It is also worth noting that the proposed repository will be approximately 300 feet above the Kuskokwim River. USGS records of Kuskokwim River flooding reach back to 1964, and no flood on record approaches a maximum stage of 300 feet (maximum flood stages have been less than 30 feet).			

TABLE C. S	TABLE C. SELECTED CLEANUP ALTERNATIVES					
Comment Number	Organization	Comment	BLM Response			
15	GTC	The Georgetown Tribal Council prefers alternative SW4 for the remediation of the site as it is the only alternative that removes the waste at the site and provides a permanent solution that protects the residents of the Kuskokwim river from the mine waste at RDM.	The EPA has developed nine criteria for evaluating the feasibility of remedial actions under CERCLA. All of the alternatives for the site were evaluated according to the EPA criteria. Cost is one criterion but is secondary to others such as consistency with applicable regulation and effective protection of human health and the environment. Alternative SW3C was selected because this action protects future potential exposure of people and wildlife to the tailings by preventing off-site migration of tailings through consolidation into an engineered repository located well away from Red Devil Creek and the Kuskokwim River. The Preferred Alternative effectively protects human health and the environment in the long term by preventing COC migration in water. On-site consolidation also avoids risks inherent in transporting over 200,000 cubic yards of high-concentration material hundreds of miles down the Kuskokwim River and thousands of miles to a facility on the Columbia River in Oregon.			

TABLE C. SELECTED CLEANUP ALTERNATIVES					
Comment Number	Organization	Comment	BLM Response		
16	GTC	The Native Village of Georgetown acknowledges the extraordinary cost of alternative SW4, however The GTC sees the expense of alternative SW4 as an investment in the future. The NVG also acknowledges the risk in transporting the RDM waste such a long distance, the NVG is confident in the BLM's ability to mitigate these risks and safely transport the waste materials to its remediation facility.	Please refer to the response to the previous comment.		
17	Private Individual	Governmental agencies need to do a better job of getting guaranteed assurances from the corporations before these mines are allowed to open. I would suggest 100 billion dollars in bonds for cleanup and yearly pop surprise inspections.	The Red Devil Mine was operated at a time when the federal government had no authority to regulate mines. In the late 1970s the BLM was authorized to regulate active mines on land the BLM manages. Our mining compliance program actively inspects mines at least once a year to ensure good mining practice and responsible mine reclamation.		
18	Private Individual	The Preferred Alternative should be undertaken to ensure the environment and wildlife and birds are protected.	Thank you for your comment, comment noted.		

## Appendix A – Applicable and Relevant and Appropriate Requirements

and Other Factors to Be Considered (TBC)

Medium	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
Federal					
Groundwater	Safe Drinking Water Act	<ul> <li>42 USC 300f et seq.</li> <li>40 CFR Part 141 subpart O appendix A, 40 CFR Part 143.</li> </ul>	Establishes MCLs for priority contaminants in drinking water systems, including groundwater used as public drinking water supplies.	MCLs would be used as potential groundwater cleanup levels for the site.	Applicable
Kuskokwim River	Clean Water Act	33 USC 1342, 40 CFR Part 122	Establishes NPDES requirements for remedial activities affecting more than 1 acre. Substantive requirements of the construction stormwater permit may be applicable.	Requirements would prescribe how stormwater is managed during remedy implementation.	Relevant and Appropriate
Kuskokwim River	Clean Water Act	33 USC 1251 et seq., 40 CFR Part 131	Establishes ambient water quality criteria necessary to support designated surface water body uses.	Criteria would be used to manage surface water quality during remedy implementation.	Relevant and Appropriate
Lower Delta Material and Kuskokwim River Sediments	Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems	MacDonald et al. 2000	Provides consensus-based sediment quality guidelines for 28 chemicals of concern.	Guidelines would be used to manage sediment quality during remedy implementation.	TBC

Medium	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
State	·				
Groundwater	Alaska Water Quality Standards	18 AAC 70.020	Establishes water quality standards that apply if contaminated water is encountered during remedial actions.	Numeric water quality standards would be used as potential groundwater cleanup levels for the site.	Applicable
Groundwater	Alaska Oil and Other Hazardous Substances Pollution Control	18 AAC 75.345 (except (a))	Establishes groundwater cleanup levels for expected potential future use.	Would be used to develop potential groundwater and surface water cleanup levels based on risk to human health.	Applicable
Groundwater and Surface Water	Alaska Oil and Other Hazardous Substances Pollution Control	18 AAC 75.345(g)	Establishes point of compliance for groundwater that is hydrologically connected to surface water.	If a point of compliance is used in the overall approach to groundwater cleanup, these regulations establish procedures for establishing a point of compliance.	Applicable
Soil	Alaska Oil and Other Hazardous Substances Pollution Control	18 AAC 75.340, and .341	Establishes soil cleanup levels.	Would be used in conjunction with background contaminant levels to establish soil cleanup levels.	Applicable

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I able A-I Chemical-S	becific Applicable or	<b>Relevant and Appro</b>	obriate Requirements

Key:

AAC = Alaska Administrative Code

NPDES = TBC

USC

National Pollutant Discharge Elimination System

to be considered

CFR = Code of Federal Regulations MCL = maximum contaminant level

= = United States Code

	Standard,				Applicable, Relevant and
	Requirement, or				Appropriate,
Location	Criteria	Citation	Description	Remedy Use	or TBC
Federal					

Bureau of Land Management "public lands" as defined in 43 U.S.C. § 1702(e)	Federal Land Policy Management Act of 1976	43 U.S.C. § 1732(a) 43 U.S.C. § 1702(c)	FLPMA provides that the Secretary of the Interior " <i>shall</i> manage the public lands under principles of multiple use and sustained yield, in accordance with the land use plans developed by him under section 1712 of this title," which means, in part, "management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people; a combination of balanced and	Provides standards for actions that take place on or affect public lands.	Applicable
			diverse resource uses that takes into account the long-term needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific and historical values; and harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment "		

Location	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
Bureau of Land Management "public lands" as defined in	Federal Land Policy Management Act of 1976	43 U.S.C. § 1732(b)	"In managing the public lands the Secretary <i>shall</i> , by regulation or otherwise, take any action necessary to prevent <b>unnecessary or undue</b>	Provides standards for actions that take place on or affect public lands.	Applicable
43 U.S.C. § 1702(e)			degradation of the lands."		

Bureau of	Federal Land	43 C.F.R. §	All land use authorizations shall:	BLM shall ensure that	Applicable
Land	Policy	2920.7	"(1) carry out the purpose of	the actions taken on	
Management	Management Act		applicable law and regulations	public lands comply	
"public lands"	of 1976		issued thereunder; (2) minimize	with the substantive	
as defined in			damage to scenic, cultural and	requirements of a land	
43 C.F.R. §			aesthetic values, fish and	use authorization.	
1601.0-5(1)			wildlife habitat and otherwise		
			protect the environment; (3)		
			require compliance with air and		
			water quality standards		
			established pursuant to		
			applicable Federal or State law;		
			and (4) Require compliance with		
			State standards for public health		
			and safety, environmental		
			protection, siting, construction,		
			operation and maintenance of, or		
			for, such use if those standards		
			are more stringent than		
			applicable Federal standards."		
			Land use authorizations shall		
			also contain such other terms		
			and conditions necessary to "(1)		
			protect Federal property and		
			economic interests; (2) manage		
			efficiently the public lands		
			which are subject to the use or		
			adjacent to or occupied by such		
			use; (3) protect lives and		
			property; (4) protect the interests		
			of individuals living in the		
			general area of the use who rely		

Location	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
			on the fish, wildlife and other biotic resources of the area for subsistence purposes; (5) require the use to be located in an area which shall cause least damage to the environment, taking into consideration feasibility and other relevant factors; and (6) otherwise protect the public interest."		
Red Devil Mine	Bering Sea- Western Interior Resource Management Plan (December 2020)	43 C.F.R. § 1610.5-3(a) and (b) https://eplanning. blm.gov/eplanni ng- ui/project/36665/ 510	Provides overall management direction and land use authorizations for BLM- managed lands covered by the RMP, including the Red Devil mine.	Establishes a framework for future management of the site following remedy implementation and will include institutional control requirements for the remedy.	Applicable
Archaeological or Historically Sensitive Areas.	Archaeological Resources Protection Act of 1979	16 USC 470aa- mm 43 CFR Part 7	Requires permits for excavation of archaeological resources on public or tribal lands.	Establishes procedures for handling and preservation of any archaeological artifacts encountered during remedy implementation.	Applicable

Location	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
Wetland Areas and/or Waters of the United States.	Protection of Wetlands, Executive Order 11990	42 FR 26961	Requires federal agencies to avoid adversely impacting wetlands wherever possible, to minimize wetlands destruction, and to preserve the values of wetlands.	Establishes rules and procedures for filling or draining wetlands during remedy implementation.	Applicable
Floodplains	Floodplain Management, Executive Order 11988	42 FR 26951	Requires federal agencies to avoid, to the extent practicable, the long- and short-term adverse impacts associated with occupancy and modification of floodplains, and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.	Establishes rules for construction of permanent features in floodplains or other floodplain modifications that could increase flood hazards during remedy implementation.	Applicable

Location	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
Streams, rivers, riparian areas, and ponds.	Fish and Wildlife Coordination Act	16 USC 661 et seq.	Requires consultation with the U.S. Fish and Wildlife Service and Alaska Department of Fish and Game for the protection of fish and wildlife when a proposed action may result in modifications to stream, river, or other surface waters of the United States.	Establishes protocols and process for coordinating with the U.S. Fish and Wildlife Service and Alaska Department of Fish and Game if water bodies are impacted by cleanup activities.	Applicable
Bird Migration Corridors	Migratory Bird Treaty Act	16 USC 703 50 CFR 10.13	Provides for the protection of international migratory birds.	Establishes rules for preservation of migratory birds during remedy implementation.	Applicable

Location	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
Critical ESA Habitat and other locations where ESA- listed species are present	Endangered Species Act	16 USC 1531 50 CFR 17, 402	Provides for the protection of fish, wildlife, and plants that are threatened with extinction. Federal agencies are required under Section 7 of the ESA to ensure that their actions will not jeopardize the continued existence of a listed species or result in destruction of or adverse modification to its critical habitat. If the proposed action may affect the listed species or its critical habitat, consultation with the U.S. Fish and Wildlife Service may be required.	Establishes rules for preservation of ESA- listed species habitat during remedy implementation.	Applicable
Bald and Golden Eagle Habitat	Bald and Golden Eagles Protection Act	16 USC 668	Provides for the protection of bald and golden eagles.	Establishes rules for protection of Bald and Golden eagles during remedy implementation.	Applicable
Fish-bearing streams and rivers	Magnuson-Stevens Fishery Conservation and Management Act	16 USC 1801- 1884	Establishes rules and process for essential fish habitat in marine and freshwater environments.	Establishes rules for preservation of essential fish habitat during remedy implementation.	Relevant and Appropriate

Location	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
State					
Fish-bearing streams and rivers.	Alaska Department of Fish and Game Anadromous Fish Act	AS 16.05.871- .901	Provides for the protection of fish and game habitats in the State of Alaska. Consultation with the Alaska Department of Fish and Game is required for any activities that could impede fish passage or that could divert, obstruct, pollute, or change the natural flow or bed of an anadro- mous water body.	Establishes procedures for coordinating with Alaska Department of Fish and Game if cleanup activities affect an anadromous water body.	Applicable

Key:

AS = Alaska Statutes

Bureau of Land Management BLM =

CFR = Code of Federal Regulations

ESA = Endangered Species Act

FR = Federal Register RMP = Resource Management Plan

TBC = to be considered

USC = United States Code

	Standard, Requirement, or				Applicable, Relevant and Appropriate,
Action	Criteria	Citation	Description	Remedy Use	or TBC
Federal				<b>T</b> + 11' 1	A 1º 1.1
Work in Waters of the United States	Clean Water Act, Section 404	33 USC 1344 40 CFR 230 33 CFR 3230	Restricts discharge of dredged or fill material into surface waters of the United States, including wetlands. If there is no practicable alternative to impacting navigable waters of the United States, then the impact must be minimized and unavoidable loss must be compensated for through mitigation on site or off	Establishes procedures and mitigation requirements for work affecting wetlands and surface water bodies during remedy implementation.	Applicable
Work in Waters of the United States	Clean Water Act – Water Quality Standards	40 CFR 131	Sets criteria for water quality based on toxicity to aquatic organisms and human health. States are given the responsibility of establishing and revising the standards, and the authority to develop standards more stringent than required by Clean Water Act.	Establishes water quality criteria for surface waters affected by remedy implementation.	Applicable
Action	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
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Work in	Rivers and	33 USC 403	Prohibits unauthorized	Establishes rules for	Applicable
Waters of the	Harbors Act,	33 CFR 3230	obstruction or alternation	dredging operations	
United States	Section 10		of navigable waters of the	during preferred	
			United States. A remedial	remedy	
			alternative that includes	implementation.	
			dredging of river sediment		
			would have to meet these		
			requirements.	<b>T 1 1 1 1 1 1</b>	
On-Site	RCRA – Criteria	40 CFR 257	Provides operational	Establishes standards	Applicable
Disposal of	for Classification	42 USC 6944	criteria by which solid	and operational	
Mine Waste	of Solid Waste		waste disposal facilities	criteria for on-site	
	Disposal Facilities		and processes must operate	disposal of mine	
	and Practices		to prevent adverse effects	waste.	
			on human health or the		
			environment. Facilities		
			failing to meet these		
			criteria are classified as		
			open dumps, which are		
			pronibiled. A remedial		
			another af a solid		
			wasta disposal facility		
			waste disposal facility		
			requirements		
1			requirements.		

Action	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
Disturbed	Invasive Species	EO 13112	Prevents the introduction	Establishes	Applicable
Alcas			provides guidance for their	of invasive species	
			control.	during remedy	
				implementation.	
State	1	1	1	1	
Work in	Clean Water Act –	18 AAC 83	Establishes discharge	Establishes criteria	Applicable
Waters of the	NPDES		limits and monitoring	for stormwater	
United States	(Delegated to the		requirements for direct	management during	
	State of Alaska for		discharges of treated	remedy	
	implementation)		effluent and stormwater	implementation.	
			runoff to surface waters of		
		10 + + 0 (0 010()	the United States.	<b>D</b> > 1111	
On-site	Alaska Solid	18 AAC 60.010(a)	Provides standards for	Establishes	Applicable
Disposal of	Waste Regulations	18 AAC 60.015	management of solid	operational criteria	
Mine Waste			waste, including	for remedy	
			requirements pertaining to		
			accumulation, storage,	involving excavation	
			treatment, transport,	and on-site disposal	
			disposal, land spreading,	of delta material or	
			landiilis, monofills,	areagea sediments	
			monitoring, and corrective	and other site-related	
			action.	waste.	

Action	Standard, Requirement, or Criteria	Citation	Description	Remedy Use	Applicable, Relevant and Appropriate, or TBC
On-site Disposal of Mine Waste	Alaska Solid Waste Regulations	18 AAC 60.217 18 AAC 60.233(1)	Provides requirements for separation of landfills from groundwater, consolidation of waste in landfills, and location standards for monofills.	Establishes requirements for remedy implementation involving excavation and on-site disposal of delta material or dredged sediments and other site-related waste.	Applicable
Monofill Construction or Relocation	Alaska Solid Waste Regulations	18 AAC 60.410	Location standards for monofills.	Establishes standards for monofill siting.	Applicable
Cleanup Confirmation Activities	Alaska Oil and Other Hazardous Substances Pollution Control	18 AAC 75.355(b) 18 AAC 75.355 (c) 18 AAC 75.355(d)	Provides requirements of cleanup confirmation sampling procedures and methods.	Establishes procedures and standards for cleanup confirmation following remedy implementation.	Applicable

	Standard,				Applicable, Relevant and
Action	Requirement, or	Citation	Description	Romody Uso	Appropriate,
Cloopup	Alaska Oil and	18 A A C 75 360 first	Provides requirements for	Establishes	Applicable
Operations	Other Hazardous	sentence	cleanup operations.	requirements for	Applicable
	Substances			cleanup operations	
	Pollution Control			prior to remedy	
				implementation.	
Post-cleanup	Alaska Oil and	18 AAC 75.375(c);	Provides requirements for	Establishes	Applicable
Activities	Other Hazardous	Alaska Statute	long-term maintenance of	requirements on	
	Substances	46.04.300390	institutional controls.	future property	
	Pollution Control			owners to maintain	
	and Uniform			institutional controls	
	Environmental			if part of the Selected	
	Covenant Act.			Remedy.	

Key:

AAC = Alaska Administrative Code

CFR = Code of Federal Regulations

EPA = U.S. Environmental Protection Agency

EO = Executive Order

NPDES = National Pollutant Discharge Elimination System

RCRA = Resource Conservation and Recovery Act

TBC = to be considered

USC = United States Code