Cleanup Action Plan
Van Stone Mine

Onion Creek, Stevens County, WA
Facility Site ID: 1554858, Cleanup Site ID: 461

Toxics Cleanup Program

Washington State Department of Ecology
Spokane, Washington

December 2023

Document Information

This document is available in the Department of Ecology's Van Stone Mine cleanup site webpage[1].

Related Information

- Facility site ID: 1554858
- Cleanup site ID: 461

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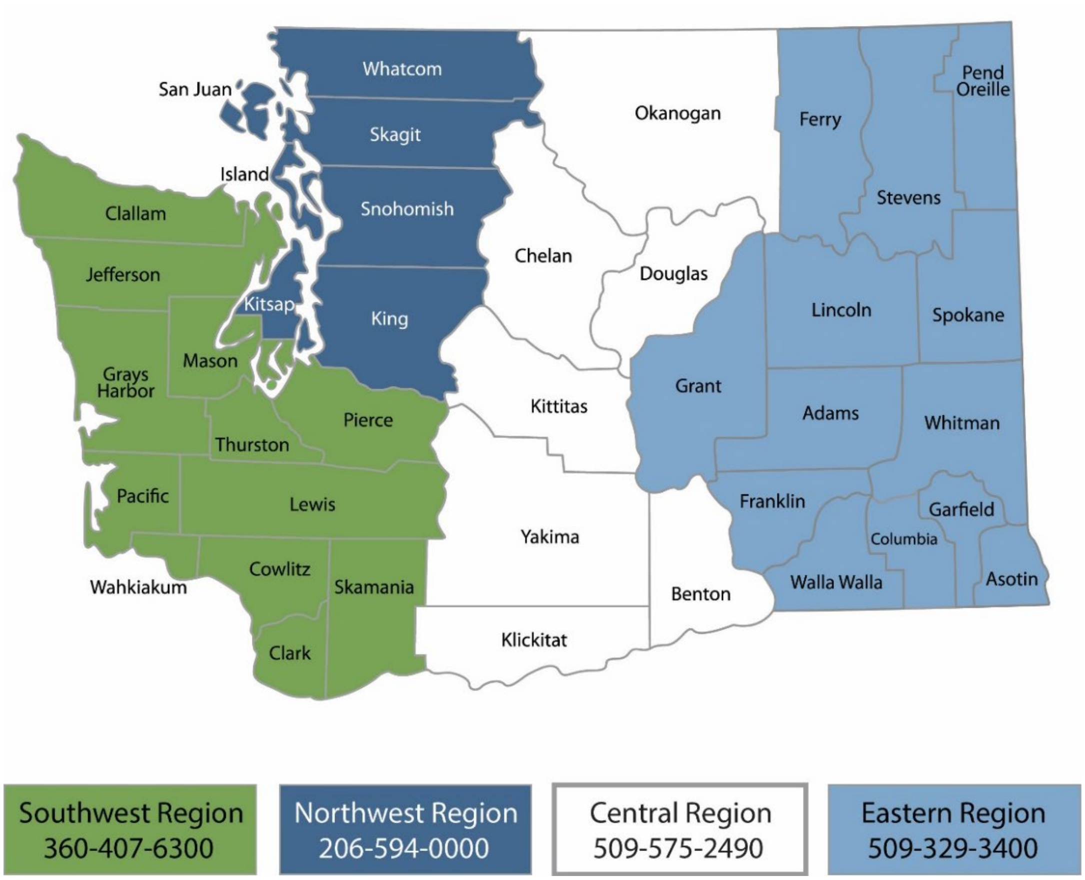
[1] https://apps.ecology.wa.gov/cleanupsearch/site/461
[2] https://ecology.wa.gov/About-us/Who-we-are/Our-Programs/Toxics-Cleanup
[3] https://ecology.wa.gov/About-us/Accountability-transparency/Our-website/Accessibility

Department of Ecology's Regional Offices

Map of Counties Served



Region	Counties served	Mailing Address	Phone
Southwest	Clallam, Clark, Cowlitz, Grays Harbor, Jefferson, Mason, Lewis, Pacific, Pierce, Skamania, Thurston, Wahkiakum	PO Box 47775 Olympia, WA 98504	360-407-6300
Northwest	Island, King, Kitsap, San Juan, Skagit, Snohomish, Whatcom	PO Box 330316 Shoreline, WA 98133	206-594-0000
Central	Benton, Chelan, Douglas, Kittitas, Klickitat, Okanogan, Yakima	1250 W Alder St Union Gap, WA 98903	509-575-2490
Eastern	Adams, Asotin, Columbia, Ferry, Franklin, Garfield, Grant, Lincoln, Pend Oreille, Spokane, Stevens, Walla Walla, Whitman	4601 N Monroe Spokane, WA 99205	509-329-3400
Headquarters	Across Washington	PO Box 46700 Olympia, WA 98504	360-407-6000

Table of Contents

1. Introduction

This report presents the Washington State Department of Ecology's (Ecology) proposed cleanup action for the Van Stone Mine (Site) located at Onion Creek, Stevens County Washington. The general location of the Site is shown in Figure A.1. Site map in Appendix A.

Ecology is responsible for selecting the cleanup action and completing the Cleanup Action Plan (CAP). The selected cleanup action is intended to fulfill the requirements of the Model Toxics Control Act (MTCA) and is a required part of the cleanup process under the following regulations and statute:

- MTCA, Chapter 70A.305 Revised Code of Washington (RCW)
- MTCA Cleanup Regulation, Chapter 173-340 of the Washington Administrative Code (WAC)

The cleanup action decision is based on the Remedial Investigation/Feasibility Study (RI/FS) and other relevant documents in the administrative record. Ecology has named Callahan Mining Corporation, Daniel Paul Sr., Equinox Resources (Wash.) Inc, Sundown Holdings Ltd., Vaagen Brothers Lumber Co. (Vaagen), Inc., and Weavers Professional Services, Inc. (Weavers Professional Services) as potentially liable persons (PLPs).

The purpose of the CAP is to identify the proposed cleanup action for the Site and to provide an explanatory document for public review that:

- Describes the history of operations, ownership, and activities at the Site
- Summarizes nature and extent of contamination
- Summarizes the cleanup action alternatives considered in the remedy selection process
- Identifies Site-specific cleanup levels (CULs) and points of compliance for each hazardous substance and medium of concern for the proposed cleanup action
- Identifies applicable state and federal laws for the proposed cleanup action
- Describes the selected cleanup action for the Site and the rationale for selecting this alternative
- Identifies residual contamination remaining on the Site after cleanup and restrictions on future uses and activities at the Site to ensure continued protection of human health and the environment
- Discusses any required compliance monitoring and institutional controls
- Presents the schedule for implementing the CAP

1.1. Declaration

Ecology has selected this remedy because it will be protective of human health and the environment. Furthermore, the selected remedy is consistent with the State of Washington's preference for permanent solutions, as stated in RCW 70A.305.040(1)(b). However, we will consider all public input before making the CAP final.

1.2. Applicability

Cleanup standards specified in this CAP are applicable only to the Van Stone Mine Site. They were developed as a part of an overall remediation process under Ecology oversight using the authority of MTCA and should not be considered as setting precedents for other sites.

1.3. Administrative record

The documents used to make the decisions discussed in this CAP are on file in the administrative record for the Site. Major documents are listed in the References section. The entire administrative record for the Site is available for public review by appointment at Ecology's Eastern Regional Office, located at 4601 N. Monroe Street, Spokane, Washington, 99205-1295. Results from applicable studies and reports are summarized to provide background information pertinent to the CAP. These studies and reports include:

- GeoEngineers, 2017. *Van Stone Mine Feasibility Study*. Prepared for Washington State Department of Ecology, GeoEngineers, May 2, 2017.
- Hart Crowser, 2012a. *Work Plan for Emergency Remedial Action, Upper Tailings Pile, Van Stone Mine*. Prepared for Washington State Department of Ecology, Hart Crowser 17800-34, October 15, 2012.
- Hart Crowser, 2012b. *Emergency Remedial Action Construction Completion Report, Upper Tailings Pile, Van Stone Mine*. Prepared for Washington State Department of Ecology, Hart Crowser 17800-34, December 26, 2012.
- Hart Crowser, 2013. *Van Stone Mine Remedial Investigation*. Prepared for Washington State Department of Ecology, Hart Crowser 17800-00, November 2013.
- MacDonald, D., C. Ingersoll, and T. Berger. 2000. "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems." *Archives of Environmental Contamination and Toxicology,* Vl. 39, pp 20-31.
- Washington State Department of Ecology, 2013. Sediment Management Standards (SMS). Publication No. 13-09-055.
- Washington State Department of Natural Resources, 2005. "Inactive and Abandoned Mine Lands – Van Stone Mine, Northport Mining District, Stevens County, Washington." *Washington Division of Geology and Earth Resources Information Circular 100*. December 2005.

1.4. Cleanup process

Cleanup conducted under the MTCA process requires the PLPs or Ecology to prepare specific documents. These procedural tasks and resulting documents, along with the MTCA section requiring their completion, are listed below with a brief description of each task.

- Public Participation Plan (WAC 173-340-600) — summarizes the methods that will be implemented to encourage coordinated and effective public involvement. Ecology prepares this document.
- RI/FS (WAC 173-340-350) — documents the investigations and evaluations conducted at the Site from the discovery phase to the RI/FS document. The RI collects and presents information on the nature and extent of contamination and the risks posed by the contamination. The FS presents and evaluates Site cleanup alternatives and may propose a preferred cleanup alternative. The documents are usually prepared by the PLPs, accepted by Ecology, and undergo public comment.
- CAP (WAC 173-340-380) — sets cleanup standards for the Site, and selects the cleanup actions intended to achieve the cleanup standards. Ecology issues the document, and it undergoes public comment.
- Engineering Design Report, Construction Plans and Specifications (WAC 173-340-400) — outlines details of the selected cleanup action, including any engineered systems and design components from the CAP. These may include construction plans and specifications with technical drawings. The PLPs usually prepare the document, and Ecology approves it. Public comment is optional.
- Operation and Maintenance Plan(s) (WAC 173-340-400) — summarizes the requirements for inspection and maintenance of remediation operations. They include any actions required to operate and maintain equipment, structures, or other remedial systems. The PLPs usually prepare the document, and Ecology approves it.
- Cleanup Action Report (WAC 173-340-400) — provides details on the cleanup activities along with documentation of adherence to or variance from the CAP following implementation of the cleanup action. The PLPs usually prepare the document, and Ecology approves it.
- Compliance Monitoring Plan (WAC 173-340-410) — details the monitoring activities required to ensure the cleanup action is performing as intended. The PLPs usually prepare the document, and Ecology approves it.

2. Site Background

This section summarizes the Site's history, investigations of contamination issues, and physical characteristics.

2.1. History

The following text and subsections are detailed in the Feasibility Study (FS) (GeoEngineers, 2017) and provided herein, with modifications as needed.

The Site is located in the Selkirk Mountains of northeastern Washington within the Onion Creek watershed headwaters, as shown in Figures A.1 and A.2. Exploration activities in the area began in the early 20th century, and Willow Creek Mines began active underground mining for lead and zinc at the Site in approximately 1938. The Site was originally operated as an underground lead and zinc mine and eventually converted to an open pit operation. Open pit mining at the south pit consumed the underground development in 1953 (DNR, 2005). To support open pit operations, ASARCO constructed a flotation mill on-Site. Open pit mining was conducted by drilling and blasting out ore reserves and trucking the ore to the mill for processing. Blasted rock not classified as ore was placed into waste rock dumps around the open pit operations. Operations ceased in 1993.

As the ore was processed though the flotation mill, lead and zinc concentrates were produced and shipped off-site. Milling process material not classified as concentrates (tailings) was transported as a slurry through pipelines to one of two disposal areas. Tailings were hydraulically placed, and coarser tailings were used to construct retainment berms along the tailings deposition perimeter. Water from the tailings was most likely decanted off and allowed to flow into nearby drainages.

The Upper Tailings Pile was used until a berm failure in 1961 resulted in a release of water and tailings into a tributary to Onion Creek. The Lower Tailings Pile was constructed after the 1961 berm failure. Tailings were placed in this lower pile for the remainder of mine operations. As part of mine reopening in 1992, Equinox reconfigured the Lower Tailings Pile and placed a polyvinyl chloride (PVC) geomembrane on top of the old tailings. In addition, a seepage collection pond was constructed out of tailings next to the facility. Tailings were then placed on top of the PVC liner during the brief restart in the 1990s. A PVC geomembrane was also installed on top of the upper tailings pile for emergency tailings storage.

After final shutdown, mine buildings, access roads, waste rock, process tailings and exposed mining faces remained. The PVC geomembrane that was installed in the tailings piles has degraded due to ultraviolet exposure.

The parcels of land comprising the Site are owned by Mr. Daniel Paul, Vaagen, and Weavers Professional Services, with Stevens County holding several parcels in trust as tax title lands under RCW 36.35. Mr. Daniel Paul owns the Mill Area and a portion of the Waste Rock Piles. His current land use is primarily for hunting. Vaagen owns portions of the Waste Rock Piles, West End Pit Lake, and the Upper Tailings Pile. Primary site use for these areas is likely timber management and harvesting. Weavers Professional Services owns a portion of the Waste Rock Piles, West End Pit Lake, and a portion of the Lower Tailings Pile. Primary site use for these areas is unknown. Stevens County holds several parcels as tax title lands on portions of the Waste Rock Piles, north and south pits, a tailings conveyance pipeline, and portions of the Lower Tailings Pile. Current land use for these areas by Stevens County is unknown.

Land use of the area surrounding the Site is primarily designated forest land; however, residential single-family properties are present to the south and northeast of the Lower Tailings Pile and next to the Mill Area. A school and two additional residential single-family parcels are near the intersection of Onion Creek Road and Lotze Creek Road on the way to the Site.

2.2. Investigations

Environmental investigations completed at the Site include:

- "Inactive and Abandoned Mine Lands – Van Stone Mine, Northport Mining District, Stevens County, Washington*." Washington Division of Geology and Earth Resources Information Circular 100*, 2005: Washington State Department of Natural Resources information circular outlining the history of the Site and production estimates.
- *Work Plan for Emergency Remedial Action, Upper Tailings Pile, Van Stone Mine*, 2012: Hart Crowser plan to evaluate the nature and extent of releases of hazardous substances and develop an engineering plan for the emergency remedial action.
- *Emergency Remedial Action Construction Completion Report, Upper Tailings Pile, Van Stone Mine*, 2012: Hart Crowser summary of the remedial activities taken to address the Upper Tailings Pile failure.
- *Van Stone Mine Remedial Investigation*, 2013: Hart Crowser, conducted RI activities. Section 3 describes the RI.
- *Van Stone Mine Feasibility Study*, 2017: GeoEngineers completed an FS that presented potential remedial actions.

2.3. Physical characteristics

2.3.1. Topography and climate

The physical setting of the Site is described in the RI and the FS with the following paragraphs and subsections comprised of text from both documents (Hart Crowser, 2013; GeoEngineers, 2017).

The Van Stone Mine is approximately 16 miles northeast of Colville in the southwest quarter of Township 38 North, Range 40 East, Willamette Meridian in Stevens County, Washington. Aerial map coverage of the Site and vicinity is shown in Figure A.1. The Lower Tailings Pile rests at an elevation of 2,770 feet (ft), the Upper Tailings Pile rests at an elevation of 3,180 ft, the Mill and Waste Rocks Areas rest at an elevation of 3,650 ft, and the West End Pit Lake rests at an elevation of 3,530 ft using Google Earth. Onion Creek borders the Site to the south and flows in a westerly direction. The Mill Areas, Waste Rock Piles, West End Pit Lake, and the Upper Tailings Pile are situated along steep slopes to the east and south. The Lower Tailings Pile, approximately two miles to the northwest from the Mill Area, is on flatter terrain with the Northeast Tributary bordering it to the north.

2.3.2. Regional hydrogeology

Groundwater at the Site occurs in the unconsolidated glacial material and underlying weathered bedrock and fractured bedrock. Nineteen domestic water wells, listed in Ecology's water supply database, are within the general area of the Site. No public water supplies were identified in the upper portion of the watershed; however, the Onion Creek School obtains its potable water from a domestic well.

A review of the well logs indicates that 16 of the wells are completed in deep fractured granitic bedrock, one well in weathered bedrock, and two in glacial material overlying bedrock.

2.3.3. Regional geology

The Van Stone Mine is located near the south end of the Kootenay Arc, otherwise known as the Selkirk Mountains Lead-Zinc Belt, extending southward from Revelstoke, British Columbia (Keston, 1970). The rocks in which the ore deposits occur are Paleozoic marine sediment overlain in part by Mesozoic formations intruded by late Mesozoic batholiths. The important mineral deposits occur as replacement deposits in carbonate rocks, but vein-type ore bodies are found, to a lesser extent, in noncalcareous rocks. The bedrock surface is extensively covered by a thick mantle of fine-to-coarse outwash from continental glaciers.

2.3.3.1. Site geology

The Van Stone Mine is located near the contact of the Cambrian age Metaline Limestone and the Spirit Pluton, an intrusive granite of Mesozoic age (Figure A.2). Unconsolidated glacial sediment consisting of till, outwash, and lacustrine soil overlie approximately 50 percent of the mine and surrounding area. Bedrock outcrops on the Site and surrounding area are characterized as either folded, faulted Paleozoic sedimentary and metasedimentary rock, or Mesozoic granitic rock on side slopes and ridges of foothills.

The Metaline Limestone is described as a hard, crystalline dolomitic limestone with sizeable open and healed fractures. Brecciated dolomite contains pods and elongated masses of sphalerite and galena. The mineralization within the Metaline Limestone is discontinuous, which created problems for the small-scale mining operations in the area (WADNR 1977, DCN 1066).

WADNR noted irregular zones of jasperiod-tremolite alteration in the dolomite host unrelated to the sulfide mineralization. Tremolite, which has some asbestiform varieties, may have been excavated in small quantities and deposited with waste rock on the Site.

Soils in the North and South Pit areas are of variable thickness and overlie Paleozoic metasedimentary rocks. A small amount of glacial overburden was removed to expose the ore deposits, but most of the overburden consisted of dolomitic limestone. The Spirit Pluton is not exposed at the tailings piles; a weathered zone of residual soil and/or colluvial material and glacial outwash covers the granite in these areas.

2.3.4. Surface water

The upper watershed is drained by Onion Creek and two large tributaries of Onion Creek: the Northeast Tributary and Southeast Tributary (Figure A.2). While a few smaller, unnamed tributaries with year-round flow are described in this section, unnamed tributaries, which are intermittent or do not flow near mine features, are not described.

2.3.4.1. Onion Creek

Onion Creek originates about 3 miles south of the Lower Tailings Pile. From its headwaters north, or downgradient to the confluence with the Southeast Tributary, the watershed is topographically isolated from mining activity (Figure A.2). Below the confluence, Onion Creek gains flow from the Southeast and Northeast tributaries, which drain areas of the Site with mining impacts. In 1961, there was substantial erosion of Onion Creek caused by a slope failure of the Upper Tailings Pile during ASARCO's operations. The failure released tailings from the Upper Tailings Pile that were conveyed downstream in the Southeast Tributary and discharged into Onion Creek.

2.3.4.2. Northeast Tributary

The Northeast Tributary trends in an east-west direction and joins Onion Creek about 1,500 feet upstream from the Onion Creek schoolhouse (Figure A.2). The Northeast Tributary drains the northern area of the upper watershed. Most of the catchment area is upgradient of the Lower Tailings Pile and outside the likely impacts of mining. The lower reach of the Northeast Tributary flows within 100 feet of the Lower Tailings Pile. During sample collection in June 2012, erosion and transport of material from the Lower Tailings Pile toward the Northeast Tributary was observed.

2.3.4.3. Southeast Tributary

The Southeast Tributary drains the southeastern portion of the upper watershed. From its headwaters, the Southeast Tributary flows southwesterly, is narrow, and is generally characterized as a down-cutting, or erosional, stream. About 1,500 feet upgradient of the confluence with Onion Creek, the Southeast Tributary begins a gradual transition with flood plain widening and areas of sediment deposition.

2.3.5. Sediment

Sediment in the upper watershed is derived from the weathering and breakdown of rock formations and soil that washes into the creeks. Grain size and angularity of the sediment is strongly influenced by their distance from the headwaters of Onion Creek and the stream and tributary gradients. The sediment observed during Site work and sediment sample collection was characterized as ranging from very coarse to fine grained.

3. Remedial Investigation

An RI was performed to assess the nature and extent of contamination. Soil, surface water, groundwater and sediments were investigated to determine whether they were impacted by Site contaminants. Additional information regarding Site activities, sampling, analyses, and methodology is in the RI (Hart Crowser, 2013). Additional sampling of soil and groundwater was conducted for the FS as well as a geotechnical assessment of the Lower Tailings Pile (GeoEngineers, 2017).

The RI/FS uses five Areas of Interest (AOIs) to subdivide the Site (Figure A.2). The AOIs were delineated based on location within the Site, the operational history of the mine, and the physical media of the Site. Within the AOIs, potentially impacted media included surface water, groundwater, soil, and sediment. The AOIs are:

- AOI-1 – Waste Rock Piles: Encompasses the geographic areas of the Site where open pits were developed, waste rock was dumped, ore rock was milled and processed, chemicals were stored, and facility and vehicle maintenance were performed.
- AOI-2 – Upper Tailings Pile: Covers the tailings pile and adjoining land where tailings may have been transported and deposited via erosion, wind, or berm failures.
- AOI-3 – Lower Tailings Pile: Covers the tailings pile and adjoining land where tailings may have been transported and deposited via erosion, wind, or berm failures.
- AOI-4 – Tailings Pipeline: Covers the tailings conveyance pipeline from the Mill Area to the Upper and Lower Tailings Piles. In addition, the AOI includes roads that may have been used as part of mining operations to access the mine/Mill Area, tailings piles, and conveyance pipelines.
- AOI-5: Onion Creek and its tributaries within the boundaries of the Site.

The RI/FS identified screening levels for a subset of metals listed in Table B.1. Screening levels used in the RI/FS are derived from MTCA Method B cleanup, SMS freshwater sediment cleanup objectives, literature-based sediment quality values, and natural background levels developed as a part of the RI. Contaminants that were not carried forward in the data evaluation process were either not detected in any samples, were detected at levels below the screening values, or are not identified as primary contaminants of concern that contribute to the overall site-risk.

The Site characterization was completed over a series of three sampling events (October and November 2011 and June 2012) as a part of the RI with additional data collected as a part of the FS in December 2014, January 2015, and October 2015. The characterization included the following:

- Installing additional monitoring wells
- Collecting and analyzing surface soil samples including tailings samples
- Collecting and analyzing surface water from Onion Creek, nearby tributaries, Pit Lake, and impoundments on the Upper and Lower Tailings Piles
- Collecting and analyzing sediment samples from Onion Creek and nearby tributaries

- Collecting and analyzing groundwater samples from nearby domestic water wells and Site monitoring wells
- Using the Preform Synthetic Precipitation Leaching Procedure (SPLP) and Toxicity Characteristic Leaching Procedure (TCLP) analysis on select tailings samples
- Conducting geotechnical stability evaluations for the Pit Lake Dam
- Determining geotechnical properties of the tailings piles for their thickness, grain size, and shear strength
- Collecting topographic data of the Site

Although several metals are found in soil, sediment, groundwater, and surface water at the Site, the RI found that lead and zinc are the most widespread at elevated concentrations. The summaries below provide a generalized overview of contamination findings from the investigation.

3.1. Soil

A total of 226 soil samples were collected from the following areas: Waste Rock/Mill Area, Upper Tailings Pile, Lower Tailings Pile, and along the Tailings Pipeline and roads. Soil samples were collected as single-point composites in the Waste Rock and Mill Area as well as along the Tailings Pipeline and roads. Transect samples analyzing soil concentrations along a gradient leading away from the Waste Rock Area, Upper Tailings Pile, and Lower Tailings Pile were used to evaluate the extent of contamination.

Analyses indicated that metals in concentrations exceeding Site screening levels are found throughout the Site. Metal concentrations typically dissipate below screening levels as you move from the Site features (for example, the Lower Tailings Pile) into the surrounding area. Metals that exceed screening levels with their maximum detected concentration (milligrams per kilogram [mg/kg]) at the Site are antimony (20), arsenic (26.5), cadmium (215), copper (640), lead (26,000), mercury (2.8), nickel (45.0), selenium (2.3), silver (3.6), thallium (1.3), and zinc (57,200) (Table B.2). Metal concentrations exceeded Site screening levels in all areas.

During the RI, diesel-range petroleum hydrocarbons (DRPH) and oil-range petroleum hydrocarbons (ORPH) were detected in soil samples within the Mill Area with maximum concentrations of 1,900 and 40,000 mg/kg, respectively. During follow-up sampling as a part of the FS, additional samples were analyzed within the same vicinity. Maximum concentrations of DRPH and ORPH during the FS sampling were found to be 123 and 1,020 mg/kg, respectively, which are below the MTCA Method A screening standards of 2,000 mg/kg for both DRPH and ORPH. Gasoline-range petroleum hydrocarbons were not detected.

In addition to collecting surficial soil samples, hollow stem borings were drilled at the Upper and Lower Tailings Piles to evaluate SPLP, TCLP, and Asbestos and Acid/Base accounting (ABA). TCLP analytical results generally indicated that the soil in the Mill Area and the tailings in the Upper Tailings Pile exceed the dangerous waste criteria for lead. SPLP analytical results indicate that most metals analyzed have the potential to leach from the tailings piles and into precipitation infiltrating through the pile at both tailings piles. At the Mill Area, only lead was found to consistently mobilize into leachate.

The ABA analysis included acid-generating potential (AGP), acid-neutralization potential (ANP), acid-base potential (ABP), and sulfur forms. The ABP is the result of the ANP minus the AGP. ABP units are presented as tons of calcium carbonate ($CaCO_3$) needed to neutralize a kiloton of waste ($CaCO_3$/Kt). A negative ABP indicates that the AGP is greater than the ANP, and thus the material has the potential to produce acid rock drainage (ARD). In general, ABP greater than 20 $CaCO_3$/Kt indicates the material does not have the potential to generate ARD. The ABP of samples from the Waste Rock Area (39.9 to 92 $CaCO_3$/Kt), Upper Tailings Pile (380 to 580 $CaCO_3$/Kt), and Lower Tailings Pile (176 to 3,900 $CaCO_3$/Kt) was indicative that the soils/tailings are highly buffering for acid and do not have the potential to produce ARD. Total sulfur results of the Waste Rock Area (less than the Method Reporting Limit [MRL] of 0.05 percent), Upper Tailings Pile (less than the MRL), and Lower Tailings Pile (less than 0.05 to 0.57 percent) was indicative of low presence of sulfur forms.

The above-mentioned hollow stem borings drilled at the Upper and Lower Tailings Piles were used to evaluate seismic conditions. The borings indicate both tailing embankments, at a current slope of 1.5H:1V, are not stable for both static and seismic conditions. A slope between 2H:1V and 3H:1V has been recommended.

The results of the slope-stability analysis of the Pit Lake Dam indicate it does not meet Ecology's Dam Safety's target factor for static long-term loading conditions with it being susceptible to failure caused by internal erosion. The instability of the Pit Lake Dam could cause downstream flooding and be a threat to human health and the environment.

As a part of the soil analysis, asbestos was also analyzed for. Asbestos results generally indicate that asbestos was not detected in the samples analyzed. Only trace quantities of Actinolite were found in the Upper Tailings Pile, and less than 1 percent was found in the Lower Tailings Pile. All other samples were found to not have any detections.

3.2. Surface water

A total of 29 surface water samples were collected throughout the RI with 21 being co-located with sediment sample locations within Onion Creek and its tributaries within the boundaries of the Site. Cadmium, lead, and zinc were detected at concentrations above screening levels (125, 5.02, and 180 micrograms per liter [µg/L] respectively; Table B.3). Samples with concentrations above screening levels were primarily taken from the Southeast Tributary of Onion Creek below the Upper Tailings Pile.

3.3. Groundwater

During the RI/FS, three rounds of groundwater sampling were conducted. Samples were collected from monitoring wells and residential wells near the Site. During the RI, a total of three monitoring wells were installed in the vicinity of the Lower Tailings Pile. Equinox previously installed four monitoring wells at the Lower Tailings Pile and two at the Upper

Tailings Pile. During the round of monitoring well sampling conducted as a part of the RI, exceedances occurred for antimony, arsenic, chromium, and lead (Table B.4). During the two rounds of groundwater sampling as a part of the FS, no exceedances were observed. One residential well sampled (RW-2) indicated arsenic was elevated; however, the reported concentration (5.3 µg/L) is generally equal to the site cleanup level of 5 µg/L.

3.4. Sediment

A total of 21 sediment samples were collected and co-located with surface water sample locations within Onion Creek and its tributaries within the Site. Only antimony and zinc were detected at concentrations above screening levels (0.59 and 459 mg/kg, respectively; Table B.5) Samples with concentrations above screening levels were primarily taken from the Southeast Tributary of Onion Creek below the Upper Tailings Pile.

3.5. Risks to human health and environment

Mine waste, including tailings and waste rock, contains a number of metals that are the contaminants of concern for the Site. Investigations have found antimony, arsenic, cadmium, chromium, copper, lead, mercury, selenium, silver, thallium, and zinc are elevated above risk-based screening levels in soil, sediment, surface water, and groundwater at the Site.

Potential receptors to Site contaminants include local residents, trespassers, wildlife, and terrestrial and aquatic organisms. Potential exposure routes include:

1. Direct human contact with exposed or near-surface contaminated soil, sediment, and surface water.
2. Incidental ingestion of soil, sediment, groundwater, or surface water by human receptors.
3. Terrestrial and aquatic ecological receptors' exposure to sediments, surface water, and soil.
4. Incidental ingestion of soil, sediment, or surface water by ecological receptors.
5. Bioaccumulation from consumption of contaminated food or prey.

The RI includes a conceptual site model (CSM) to describe surface and subsurface conditions, define the nature and extent of known contamination, and identify potential exposure pathways from site sources of contaminants to potential receptors.

4. Cleanup Standards

MTCA requires the establishment of cleanup standards for individual sites. The two primary components of cleanup standards are CULs and points of compliance. CULs determine the concentration at which a substance does not threaten human health or the environment. All media exceeding a CUL is addressed through a cleanup remedy that prevents exposure to the contaminated material. Points of compliance represent the locations on the site where CULs must be met.

4.1. Overview

The process for establishing CULs involves the following:

- Determining if methods A, B, or C are applicable
- Developing CULs for individual contaminants in each media
- Determining which contaminants contribute the majority of the overall risk in each media (indicators)
- Adjusting the CULs downward for carcinogenic substances based on total site risk of 1×10^{-5}, and for a hazard index of 1 for non-carcinogenic substances, if necessary

MTCA provides three options for establishing CULs: methods A, B, and C.

- Method A may be used to establish CULs at routine sites or sites with relatively few hazardous substances.
- Method B is the standard method for establishing CULs and may be used to establish CULs at any site.
- Method C is a conditional method used when a CUL under Method A or B is technically impossible to achieve or may cause significantly greater environmental harm. Method C also may be applied to qualifying industrial properties.

MTCA defines the factors used to determine whether a substance should be retained as an indicator for the Site. When defining CULs at a site contaminated with several hazardous substances, Ecology may eliminate contaminants contributing a small percentage of the overall threat to human health and the environment. WAC 173-340-703(2) provides a substance may be eliminated from further consideration based on:

- The toxicological characteristics of the substance which govern its ability to adversely affect human health or the environment relative to the concentration of the substance
- The chemical and physical characteristics of the substance which govern its tendency to persist in the environment
- The chemical and physical characteristics of the substance which govern its tendency to move into and through the environment
- The natural background concentration of the substance
- The thoroughness of testing for the substance
- The frequency of detection
- The degradation by-products of the substance

4.2. Site use

The evaluation of CULs and ecological exposures depends on the nature of the Site use. Options under MTCA are either an unrestricted property or an industrial property. Industrial properties are defined in WAC 173-340-200; the definition includes properties characterized by transportation areas and facilities zoned for industrial use. Industrial properties are further described in WAC 173-340-745(1) by the following factors:

- People do not normally live on industrial property
- Access by the general public is generally not allowed
- Food is not grown/raised
- Operations are characterized by chemical use/storage, noise, odors, and truck traffic
- Ground surface is mostly covered by buildings, paved lots and roads, and storage areas
- Presence of support facilities serving the industrial facility employees and not the general public

The parcels of land comprising the Site are zoned for unrestricted land use. The primary uses of the Site are hunting and timber management and harvesting. Near the Site are residential properties as well as a school. As a result of the land use and its current designations, MTCA Method C CULs are not applicable to this Site.

4.3. Terrestrial ecological evaluation

WAC 173-340-7490 requires site managers to perform a terrestrial ecological evaluation (TEE) to determine the potential effects of soil contamination on ecological receptors. A site may be excluded from a TEE if any of the following are met:

- All contaminated soil is or will be located below the point of compliance
- All contaminated soil is or will be covered by physical barriers such as buildings or pavement
- The site meets certain requirements related to the nature of on-site and surrounding undeveloped land
- Concentrations of hazardous substances in soil do not exceed natural background levels

This Site does not meet any of the exclusionary criteria nor does it qualify for a simplified evaluation. A site-specific TEE was conducted at the Site. While the mining operations are considered an industrial use, the proximity of unrestricted land use required the TEE to consider the Site as an unrestricted land use site. The Site is surrounded by forest lands, and wetlands have been identified on-Site. Therefore, plants, soil biota, and wildlife are considered as receptors.

4.4. Indicator substances

Indicator substances as defined by WAC 173-340-200 are a subset of hazardous substances present at a site selected under WAC 173-340-708 for monitoring and analysis during any phase of remedial action for the purpose of characterizing a site or establishing cleanup requirements for a site.

Metals have been identified as chemicals of concern at the Site. Indicator substances are selected from the list of chemicals of concern. The criteria found in WAC 173-340-708 (2) are used to screen the list of chemicals. The results of each media's indicator substance screening are described in the following subsections with the final list of indicator substances for the Site listed in Table B.6.

4.4.1. Soil/tailings indicator substances

The most likely pathway for exposure to the contaminated soil and tailings is through direct contact and ingestion. The current land use is considered unrestricted, and this was used when evaluating human and ecological receptors. Protection of groundwater and surface water is also a consideration.

Beryllium and chromium were excluded as indicator substances, as their maximum concentrations in soil were below the Site screening levels. Nickel was also excluded as an indicator substance in soil, as only one sample exceeded its screening level, and that concentration was less than two-times the screening level, indicating that nickel did not contribute to the overall site risk. DRPH and ORPH were also excluded as indicator substances due to the contaminants being found only in a small part of the Mill Area. Follow-up sampling indicated concentrations were below Method A, and terrestrial wildlife screening levels indicated they do not contribute to the overall Site risk.

Antimony, arsenic, cadmium, copper, lead, mercury, selenium, silver, thallium, and zinc are the indicator substances for soil. Soil indicator substance screening results are presented in Table B.2.

4.4.2. Surface water indicator substances

Surface water samples collected on-site from the Pit Lakes and the impoundments on the Upper and Lower Tailings Piles indicate surface water quality criteria has been exceeded for metals. Soil and groundwater CULs will be protective of surface water.

Copper, mercury, and nickel were excluded as indicator substances, as their maximum concentrations in surface water were below the Site screening levels. Arsenic, beryllium, chromium, selenium, silver, and thallium were also excluded, as they were not detected in surface water.

Antimony, cadmium, lead, and zinc are the indicator substances for surface water. Surface water indicator substance screening results are presented in Table B.3.

4.4.3. Groundwater indicator substances

The most likely pathway for exposure to contaminated groundwater is through ingestion. Protection of soil and surface water is also a consideration.

Beryllium, chromium, copper, mercury, nickel, silver and zinc were excluded as indicator substances, as their maximum concentrations in groundwater were below the Site screening levels. Cadmium was excluded as an indicator substance in groundwater, as only one sample exceeded its screening level and the concentration in that sample was less than two-times the screening level indicating that it does not contribute to the overall site risk. Selenium was excluded since it was not detected in groundwater.

Antimony, arsenic, and lead are the indicator substances for groundwater. Groundwater indicator substance screening results are presented in Table B.4.

4.4.4. Sediment indicator substances

The most likely pathway for exposure to contaminated sediments is through direct contact and ingestion by sediment biota. Human health and terrestrial wildlife exposure scenarios were also considered as there is potential for incidental contact and ingestion due to the periodic flow of the tributaries. Antimony, beryllium, chromium, copper, mercury, nickel, silver, and thallium were excluded as indicator substances as their maximum concentrations in sediment were below the Site screening levels. Arsenic and cadmium were excluded as indicator substances in sediment as there were low frequency of detections above the CUL (less than 5 percent) and those concentrations were less than two-times the screening level indicating that they do not contribute to the overall site risk.

Lead, selenium, and zinc are the indicator substances for sediment. Sediment indicator substance screening results are presented in Table B.5.

4.5. Site cleanup levels

The indicator substance screening produced a total of ten metal contaminants across all media (soil, groundwater, surface water, and sediments) that were forwarded for cleanup standard development. As a part of the RI, natural background, in accordance with WAC 173-340-709, was calculated for soil and sediment for the Onion Creek watershed. The methods and calculations can be found in the RI report (Hart Crowser, 2012a). The calculated background metal concentrations are used as a part of this cleanup standard development. CULs for individual substances are then adjusted downwards, if need be, to account for exposure to multiple hazardous substances from more than one pathway of exposure. These adjustments only need to be made if, without these adjustments, the hazard index would exceed one (1) and the total excess cancer risk would exceed one in one hundred thousand ($1x10^{-5}$) (WAC 173-340-708). CULs based upon background are not included in the overall site-risk calculations. For the Site, the overall site-risk for hematotoxicity was $1.1x10^{0}$ with an overall excess cancer risk of 0 (Table B.12). Downward adjustment of CULs was required for the Site to reduce the overall Site risk. A downward adjustment of the antimony CUL in soil to background was done (Table B.8.) which brought the overall Site risk to $9.42x10^{-1}$ for hematotoxicity (Table B.13).

4.5.1. Soil cleanup levels

Soil cleanup concentrations set under Method B shall be at least as stringent as the criteria in WAC 173-340-740(3)(b), which includes the following:

- Concentrations established under applicable state and federal laws.
- No significant adverse effects on the protection and propagation of terrestrial ecological receptors established using the procedures specified in WAC 173-340-7490 through 173-340-7494.
- For hazardous substances for which sufficiently protective, health-based criteria or standards have not been established under applicable state and federal laws, those concentrations that protect human health as determined by the equations presented in WAC 173-340-740(3)(b)(iii)(A) and (B).

Soil CULs were developed for 10 metals identified as indicator substances. The indicator substances are antimony, arsenic, cadmium, copper, lead, mercury, selenium, silver, thallium, and zinc (Table B.2). The arsenic (5.04 mg/kg), cadmium (1.60 mg/kg), mercury (0.13 mg/kg), selenium (1.65 mg/kg), and zinc (206 mg/kg) CULs were adjusted since their respective lowest screening values are below the natural background concentration for the Onion Creek watershed (Table B.2). The soil cleanup levels for antimony (5 mg/kg), lead (50 mg/kg), and silver (2 mg/kg) were established using the TEE table values. The CUL for copper (50 mg/kg) is the screening level that is protective of groundwater through surface water. The thallium CUL (0.23 mg/kg) was established using the Method B value that is protective of human health. The CUL for antimony was further adjusted downwards to natural background (0.86 mg/kg) (Table B.8), as the overall site-risk for hematotoxicity was exceeded when the initial CUL of 5 mg/kg for the protection of terrestrial ecological receptors was applied.

4.5.2. Surface water cleanup levels

Surface water cleanup concentrations set under Method B shall be at least as stringent as the criteria in WAC 173-340-730(3)(b), which includes the following:

- Concentrations established under applicable state and federal laws.
- No significant adverse effects on the protection and propagation of wildlife, fish, and other aquatic life.

For hazardous substances for which sufficiently protective, health-based criteria or standards have not been established under applicable state and federal laws, those concentrations which protect human health as determined by the equations presented in WAC 173-340-730(3)(b)(iii)(A) and (B).

Surface water CULs were developed for four metals that were identified as indicator substances. The indicator substances are antimony, cadmium, lead, and zinc (Table B.3). The antimony CUL (5.6 µg/L) is based upon the Clean Water Act Protection of Human Health. The cadmium CUL (1.16 µg/L) is based on the Clean Water Act Chronic Protection of Aquatic

Organisms. The lead (5.02 µg/L) and zinc (180 µg/L) CULs are based on the chronic water quality standards of Washington State (WAC 173-201A) (Table B.3).

4.5.3. Groundwater cleanup levels

Groundwater cleanup concentrations set under Method B shall be at least as stringent as the criteria in WAC 173-340-720(4)(b), which includes the following:

- Concentrations established under applicable state and federal laws.
- Protection of surface water beneficial uses.

For hazardous substances for which sufficiently protective, health-based criteria or standards have not been established under applicable state and federal laws, those concentrations that protect human health as determined by the equations presented in WAC 173-340-720(4)(b)(iii)(A), (B) and (C).

Groundwater CULs were developed for three metals that were identified as indicator substances. The indicator substances are antimony, arsenic, and lead (Table B.4). The antimony (6 µg/L) and lead (15 µg/L) CULs are based on the Washington State drinking water maximum contaminant levels (MCL) (Table B.4). The arsenic (5 µg/L) level is based on the background drinking water conditions of eastern Washington (Table B.4).

4.5.4. Sediment cleanup levels

Sediment cleanup concentrations are set at the level of biological effects of a contaminant in sediment by Ecology to be protective of human health and the environment. The sediment CUL is established in accordance with the following requirements set forth in WAC 173-204-560:

- The sediment CUL shall initially be established at the sediment cleanup objective.
- The sediment CUL may be adjusted upward from the sediment cleanup objective based on whether it is technically feasible to achieve the sediment CUL at the applicable point of compliance and whether meeting the sediment CUL will have a net adverse effect environmental impact.

The sediment CUL may not be adjusted upward above the cleanup screening level.

Sediment CULs were developed for three metals that were identified as indicator substances. The indicator substances for sediment were lead, selenium, and zinc (Table B.5). The CULs for lead (50 mg/kg) and zinc (86 mg/kg) are based on the Method B soil protections of human health (Table B.5). The Method B CUL for both lead and zinc is for the protection of terrestrial organisms. The CUL for selenium (0.52 mg/kg) was adjusted upwards to natural background concentrations found within the Onion Creek Watershed.

4.6. Point of compliance

MTCA defines the point of compliance as the point or points where CULs shall be attained. Once CULs are met at the point of compliance, the Site is no longer considered a threat to human health or the environment.

WAC 173-340-740(6) gives the point of compliance requirements for soil. The standard point of compliance for soil CULs based on protection of the direct contact pathway is established at a depth of 15 feet. The standard point of compliance for soil CULs based on protection of groundwater is throughout the soil column. Additionally, for any upland remedy that is also protective of terrestrial ecological receptors, a conditional point of compliance may be set at the biologically active soil zone. Ecology assumes this zone extends to a depth of 6 feet.

However, Ecology recognizes that for cleanup actions that involve containing hazardous substances, soil CULs will typically not be met at the soil point of compliance. In these cases, the cleanup action may be determined to comply with cleanup standards, provided:

- The selected remedy is permanent to the maximum extent practicable using the procedures in WAC 173-340-360.
- The cleanup action is protective of human health.
- The cleanup action is demonstrated to be protective of terrestrial ecological receptors under WAC 173-340-7490 through 173-340-7494.
- Institutional controls are put in place under WAC 173-340-440 that prohibit or limit activities that could interfere with the long-term integrity of the containment system.
- Compliance monitoring under WAC 173-340-410 and periodic reviews under WAC 173-340-430 are designed to ensure the long-term integrity of the containment system.
- The types, levels, and amounts of hazardous substances remaining on-site and the measures that will be used to prevent migration and contact with those substances are specified in the CAP.

For this Site, the soil point of compliance will be throughout the Site from ground surface to 15 feet below ground surface (bgs).

The standard point of compliance for groundwater CULs will be all groundwater beneath the Site from the top of the saturated zone extending vertically to the lowest depth that could potentially be affected by the Site.

The point of compliance for surface water will be the point (or points) at which hazardous substances are released to surface waters. For this Site, meeting the soil point of compliance will satisfy the surface water point of compliance.

The SMS specifies that Ecology develop the point of compliance for sediment at a location that protects aquatic life and human health. Ecology generally applies the point of compliance for sediment to the extent of the biologically active zone, generally 6 to 12 inches bgs. For this Site, the sediment point of compliance is from ground surface to 1-foot bgs.

5. Cleanup Action Selection

5.1. Remedial action objectives

Remedial action objectives describe the actions necessary to protect human health and the environment by eliminating, reducing, or otherwise controlling risks posed through each exposure pathway and migration route. They are developed considering the characteristics of the contaminated media, the characteristics of the hazardous substances present, migration and exposure pathways, and potential receptor points.

Given these potential exposure pathways, the following are the remedial action objectives for the Site:

- Prevent direct contact, ingestion, or inhalation of contaminated soil by humans and terrestrial biota.
- Prevent direct contact or ingestion of contaminated groundwater by humans.
- Prevent direct contact or ingestion of contaminated surface water by humans and terrestrial and aquatic biota.
- Prevent direct contact or ingestion of contaminated sediments by humans and terrestrial and aquatic biota.

5.2. Cleanup action alternatives

The FS proposed six remedial alternatives. Alternative 1 is no action and was not considered for evaluation since it did not meet the criteria outlined in WAC 173-340-360, which is further described below. Alternative 2 would use institutional controls only, while alternatives 3 through 5 would use a combination of in-place containment with or without a cover system, regrading slopes, revegetation, and institutional controls. Alternative 6 is off-site disposal of contaminated materials.

All alternatives would include addressing the spillway at the North Pit Lake through installing a buttress, increasing the cross section, flattening the slopes to stabilize and bring it under Dam Safety requirements.

Alternatives 2 through 6 are presented below.

5.2.1. Alternative 2 – Institutional controls and monitoring

Alternative 2 would eliminate potential Site risks by limiting future land use and access to the tailings piles, Waste Rock Piles, Mill Area, and pit lakes through using fencing, warning signs, restrictive covenants, and other administrative institutional controls. No source or contaminant remediation would occur.

5.2.2. Alternative 3 – In-place containment without cover system

Alternative 3 consists of an in-place containment of the Upper and Lower Tailings Piles, and the Waste Rock Piles. The Upper and Lower Tailings Piles would be regraded to have a slope of 3H:1V or less, and the Waste Rock Piles would be graded to blend into the natural contours. Buttresses, reinforce stabilized slopes, and benches could be used to enhance the stability and reduce the overall slope. A cover system would not be used; however, plant seed would be applied to the surfaces, and the areas would be left to naturally revegetate over time.

Dispersed tailings associated with the Tailings Pipelines would not be removed.

Long-term monitoring would be required, and institutional controls would limit Site use.

5.2.3. Alternative 4 – In-place containment with cover system

Alternative 4 is the same as Alternative 3 with the following additions:

- A cover system installed at the Upper and Lower Tailings Piles consisting of 12 oz. nonwoven geotextile, 60-mil high-density polyethylene (HDPE) geomembrane, 12 oz. nonwoven geotextile, a Geonet drainage geotextile, 2 feet of borrow material, and 1 foot of vegetated topsoil;
- Dispersed tailings associated with the Tailings Pipelines and contaminated sediments would be hand shoveled and consolidated on the closest tailing pile;
- Dangerous waste would be removed from the Mill Area/Waste Rock Area and placed directly and near the center of the Upper Tailings Pile and then covered with additional tailings prior to the cover system being installed.

Long-term monitoring would be required, and institutional controls would limit Site use.

5.2.4. Alternative 5 – Centralized tailings repository

Alternative 5 would implement the same cover systems as Alternative 4; however, the Upper Tailings Pile and the dangerous waste from the Mill Area/Waste Rock Area would be consolidated onto the Lower Tailings Pile. The dispersed tailings associated with the Tailings Pipelines and contaminated sediments would be consolidated on the Lower Tailings Pile. The dangerous waste from the Mill Area/Waste Rock Area would be placed near the center of the repository on top of the Lower Tailings Pile and covered with tailings from the Upper Tailings Pile. The excavated areas from the Upper Tailings Pile and the Mill Area/Waste Rock Area would be regraded and vegetated.

Long-term monitoring would be required, and institutional controls would limit Site use.

5.2.5. Alternative 6 – Off-site disposal

Alternative 6 would involve excavating tailings, waste rock, and other materials that exceed TCLP and hauling them off-site for disposal. The closest landfill that would accept the materials is the Waste Management facility in Arlington, Oregon. The excavated areas would be graded and revegetated.

5.3. Regulatory requirements

MTCA sets forth the minimum requirements and procedures for selecting a cleanup action. A cleanup action must meet each of the minimum requirements specified in WAC 173-340-360(2), including certain threshold and other requirements.

5.3.1. Threshold requirements

WAC 173-340-360(2)(a) requires that the cleanup action shall:

- Protect human health and the environment
- Comply with cleanup standards (see Section 4.5)
- Comply with applicable state and federal laws (see Section 5.3.4)
- Provide for compliance monitoring

5.3.2. Other requirements

In addition, WAC 173-340-360(2)(b) states the cleanup action shall:

- Use permanent solutions to the maximum extent practicable
- Provide for a reasonable restoration time frame
- Consider public concerns

WAC 173-340-360(3) describes the specific requirements and procedures for determining whether a cleanup action uses permanent solutions to the maximum extent practicable. A permanent solution is defined as one where CULs can be met without further action being required at the Site other than the disposal of residue from the treatment of hazardous substances. To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, a disproportionate cost analysis is conducted. This analysis compares the costs and benefits of the cleanup action alternatives and involves the consideration of several factors, including:

- Protectiveness
- Permanent reduction of toxicity, mobility, and volume
- Cost
- Long-term effectiveness
- Short-term risk
- Implementability
- Consideration of public concerns

The comparison of benefits and costs may be quantitative but will often be qualitative and require the use of best professional judgment.

WAC 173-340-360(4) describes the specific requirements and procedures for determining whether a cleanup action provides for a reasonable restoration time frame.

5.3.3. Cleanup action expectations

WAC 173-340-370 sets forth the following expectations for the development of cleanup action alternatives and the selection of cleanup actions. These expectations represent the types of cleanup actions Ecology considers likely results of the remedy selection process; however, Ecology recognizes there may be some sites where cleanup actions conforming to these expectations are not appropriate.

- Treatment technologies will be emphasized at sites with liquid wastes, areas with high concentrations of hazardous substances, or with highly mobile and/or highly treatable contaminants
- To minimize the need for long-term management of contaminated materials, hazardous substances will be destroyed, detoxified, and/or removed to concentrations below CULs throughout sites with small volumes of hazardous substances
- Engineering controls, such as containment, may need to be used at sites with large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable
- To minimize the potential for migration of hazardous substances, active measures will be taken to prevent precipitation and runoff from coming into contact with contaminated soil or waste materials
- When hazardous substances remain on-site at concentrations which exceed CULs, they will be consolidated to the maximum extent practicable where needed to minimize the potential for direct contact and migration of hazardous substances
- For sites adjacent to surface water, active measures will be taken to prevent/minimize releases to that water; dilution will not be the sole method for demonstrating compliance
- Natural attenuation of hazardous substances may be appropriate at sites under certain specified conditions (see WAC 173-340-370(7))
- Cleanup actions will not result in a significantly greater overall threat to human health and the environment than other alternatives

5.3.4. Applicable, relevant, and appropriate state and federal laws, and local requirements

WAC 173-340-710(1) requires that all cleanup actions comply with all applicable local, state, and federal law. It further states the term "applicable state and federal laws" shall include legally applicable requirements and those requirements that the department determines "…are relevant and appropriate requirements." This section discusses applicable state and federal law, relevant and appropriate requirements, and local permitting requirements that were considered and were of primary importance in selecting cleanup requirements. If other requirements are identified later, they will be applied to the cleanup actions at that time.

MTCA provides an exemption from the procedural requirements of several state laws and from any laws authorizing local government permits or approvals for remedial actions conducted under a consent decree, order, or agreed order (RCW 70A.305.090). However, the substantive requirements of a required permit must be met. The procedural requirements of the following state laws are exempted:

- Ch. 70A.15 RCW, Washington Clean Air Act
- Ch. 70A.205 RCW, Solid Waste Management—Reduction and Recycling

- Ch. 70A.300 RCW, Hazardous Waste Management
- Ch. 77.55 RCW, Construction Projects in State Waters
- Ch. 90.48 RCW, Water Pollution Control
- Ch. 90.58 RCW, Shoreline Management Act of 1971

WAC 173-340-710(4) sets forth the criteria Ecology evaluates when determining whether certain requirements are relevant and appropriate for a cleanup action. Table B.1 in lists the local, state, and federal laws containing the applicable or relevant and appropriate requirements that apply to the cleanup action at the Site. Local laws, which may be more stringent than specified state and federal laws, will govern where applicable.

5.4. Evaluation of cleanup action alternatives

The requirements and criteria outlined in Section 5.3 are used to conduct a comparative evaluation of the cleanup action alternatives and to select a cleanup action from those alternatives. Table B.14 provides a summary of the ranking of the deep contamination alternatives against the various criteria.

5.4.1. Threshold requirements

5.4.1.1. Protection of human health and the environment

The remedial alternatives combine institutional controls, removal, and capping to protect human health and the environment. Removal and capping would reduce potential human and ecological receptors by reducing the exposure pathways. As such, alternatives 4, 5, and 6 would protect human health and the environment. Alternatives 2 and 3 do not provide protection of human health and the environment to contaminated materials, as the materials will neither be removed or capped.

5.4.1.2. Compliance with cleanup standards

Alternatives 4 and 5 meet cleanup standards by capping the contaminated materials. Alternative 6 will also meet cleanup standards by removing the contaminated materials for off-site disposal. Alternatives 2 and 3 do not meet cleanup standards because contaminated materials will neither be removed or capped.

5.4.1.3. Compliance with state and federal laws

Alternatives 4, 5, and 6 can meet regulatory requirements, as discussed in Section 6.3.4. Local laws, which can be more stringent, will govern actions when they are applicable. The design phase of this project will further establish relevant state and federal laws. Alternatives 2 and 3 do not comply with MTCA regulations.

5.4.1.4. Provide for compliance monitoring

There are three types of compliance monitoring: protection, performance, and confirmational. Protection monitoring is designed to protect human health and the environment during the construction and operation and maintenance phases of the cleanup action. Performance monitoring confirms the cleanup action has met cleanup and/or performance standards. Confirmational monitoring confirms the long-term effectiveness of the cleanup action once cleanup standards have been met or other performance standards have been attained.

Each remedial alternative requires varying levels of all three types of compliance monitoring. Performance monitoring will track the effectiveness of the cleanup action and determine if it achieved cleanup standards. The Operating and Maintenance (O&M) plan will describe these monitoring activities. Health and safety plans will include protection monitoring requirements for remedial construction and final remedy O&M. All alternatives satisfy this provision.

5.4.2. Other requirements

5.4.2.1. Use of permanent solutions to the maximum extent practicable

To determine whether a cleanup action uses permanent solutions to the maximum extent practicable, the disproportionate cost analysis is used. The analysis compares the costs and benefits of the cleanup action alternatives and involves the consideration of several factors. The comparison of costs and benefits may be quantitative but will often be qualitative and require the use of best professional judgment. Table B.14 provides a summary of the relative ranking of each alternative in the decision process.

- Protectiveness measures the degree to which existing risks are reduced, time required to reduce risk and attain cleanup standards, on- and off-site risks resulting from implementing the alternative, and improvement of overall environmental quality.

Alternatives 4, 5, and 6 are protective of human health and the environment. Alternative 6 will provide for the greatest long-term protectiveness by removing site contaminants to off-site disposal. Alternative 2, which relies solely on institutional controls and monitoring, also is not protective of human health and the environment. While Alternative 3 stabilizes the Tailings Piles and Waste Rock Piles, it will not attain cleanup standards.

- Permanent reduction of toxicity, mobility, and volume measures the adequacy of the alternative in destroying the hazardous substance(s), the reduction or elimination of releases or sources of releases, the degree of irreversibility of any treatment process, and the characteristics and quantity of any treatment residuals.

Alternative 6 provides the most permanent reduction in toxicity, as it removes contaminants off-site. Alternatives 4 and 5 also provide permanent reduction in contaminant exposure as they rely on capping and institutional controls. Alternative 5 would provide a more permanent reduction than Alternative 4, as the Site materials would be consolidated into one impoundment area instead of two separate impoundments. Alternatives 2 and 3 do not provide for a permanent reduction in contaminant exposure.

- Cleanup costs are estimated based on design assumptions for each alternative. Although the costs are estimates based on design assumptions that might change, the relative costs can be used for this evaluation. For a detailed description of the costs involved with each alternative, please refer to the FS.

Estimated cleanup cost for each alternative:

- Alternative 2: $903,400
- Alternative 3: $4,863,076
- Alternative 4: $14,361,469
- Alternative 5: $13,960,482
- Alternative 6: $448,143,116

- Long-term effectiveness measures the degree of success, the reliability of the alternative during the period that hazardous substances will remain above cleanup levels, the magnitude of residual risk after implementation, and the effectiveness of controls required to manage remaining wastes.

Alternative 6 provides the most long-term effectiveness as it removes contaminants off-site. Alternatives 4 and 5 also provide for long-term effectiveness. Alternatives 2 and 3 do not provide for long-term effectiveness in eliminating exposure to contaminants.

- Short-term risk measures the risks related to an alternative during construction and implementation, and the effectiveness of measures that will be taken to manage such risks.

Alternative 6 poses the most short-term risks, as it requires excavation of both tailings piles as well as the Waste Rock Piles and transporting the contaminated material on public roadways. Alternative 5 would also have short-term risks because it consolidates the Site contamination into a single repository by transporting contaminated material over public roadways, albeit over a significantly shorter distance than Alternative 6. Alternative 4 has similar short-term risk as Alternative 4; however, less material would be transported over public roadways. Construction will occur in a manner not to create contaminated material movement during or after construction. Ecology anticipates construction will occur almost entirely with land-based equipment.

- Implementability considers whether the alternative is technically possible, the availability of necessary off-site facilities, services, and materials, administrative and regulatory requirements, scheduling, size, complexity, monitoring requirements, access for operations and monitoring, and integrations with existing facility operations.

All Alternatives are implementable at the Site. Alternatives 4, 5, and 6 would require advance planning for construction activities with the remedial action being implemented in multiple phases over several years.

- To understand and consider public concerns, Ecology presented the draft RI/FS for public review and comment. This CAP will also undergo public review and comment.

Ecology published our Response to Comments[4] in August 2017. We received comments from three individuals. You can learn more by reading the document.

[4] https://apps.ecology.wa.gov/cleanupsearch/document/65919

5.4.2.2. Disproportionate cost analysis results

Costs are disproportionate to the benefits if the incremental costs of an alternative are disproportionate to the incremental benefits of that alternative. Based on an analysis of the factors listed above, the additional costs of Alternative 2 are disproportionate to its incremental benefit. Table B.14 provides a summary of the relative ranking of each alternative in the decision process. Figure A.3 summarizes the disproportionate cost analysis.

5.4.2.3. Provide for a reasonable restoration time frame

WAC 173-340-360(4) describes the requirements and procedures for determining whether a cleanup action provides for a reasonable restoration time frame, as required under subsection (2)(b)(ii). The factors used to determine whether a cleanup action provides a reasonable restoration time frame are in WAC 173-340-360(4)(b).

Alternatives 4, 5, and 6 have similar restoration time frames. Each alternative is consistent with the factors in WAC 173-340-360(4)(b). Alternatives 2 and 3 do not meet these criteria, as they lack the ability to control the migration of hazardous substances.

5.4.3. Groundwater cleanup requirements

Cleanup actions that address groundwater must meet the requirements described in WAC 173-340-360(2)(c). Groundwater contamination at the Site is most likely attributed to precipitation infiltrating through the tailings piles and mobilizing contaminants into groundwater. Alternatives 4, 5, and 6 remove this pathway, as the tailings and Waste Rock Piles will either removed off-site or have a cover system placed over them.

5.4.4. Cleanup action expectations

Cleanup action expectations are outlined in WAC 173-340-370 and are described in Section 5.3.3. The alternatives would address applicable expectations in the following manner:

- Alternative 6 would involve excavating tailings, waste rock, and other materials that exceed TCLP and hauling them off-site for disposal.
- Alternatives 4 and 5 consolidate and cap the tailings and waste rock from Site.
- Alternative 3, while stabilizing the slopes and including intuitional controls, does not contain or limit exposure to contaminated materials, and therefore, does not meet cleanup expectations.
- Alternative 2 relies solely on institutional controls, and therefore, does not meet cleanup expectations.

5.5. Decision

Based on the analysis described above, Alternative 5 has been selected as the proposed remedial action for the Site. The selected cleanup action is designed to meet the MTCA requirements and expectations. The cleanup action will be protective of human health and the environment. Ecology is selecting Alternative 5 as presented in the FS. The selected cleanup action will protect human and terrestrial ecological receptors from exposure to metals in the tailings and waste rock. The containment remedy using a cover system will reduce and control groundwater and surface water contamination as well as prevent the erosion of tailings that can threaten human health through catastrophic failures. The consolidation of the Upper Tailings Pile into the Lower Tailings Pile will also reduce the amount of long-term maintenance needed as well as open up the excavated Upper Tailings Pile area for other potential uses in the future.

6. Selected Cleanup Action

The selected cleanup action includes the following major components:

- The Upper Tailings Pile and the dangerous waste at the Mill Area/Waste Rock Area will be consolidated onto the Lower Tailings Pile
- The Lower Tailings Pile will be regraded to have a slope of 3H:1V or less
- A cover system will be installed at the Lower Tailings Pile consisting of 12-oz. nonwoven geotextile, 60-mil HDPE geomembrane, 12-oz. nonwoven geotextile, a Geonet drainage geotextile, 2 feet of borrow material, and 1 foot of vegetated topsoil
- Dispersed tailings associated with the Tailings Pipelines will be consolidated on the Lower Tailings Pile
- Remaining material in the Waste Rock Area will be graded to match the Site contours
- Addressing the spillway at the North Pit Lake through installing a buttress, increasing the cross section, flattening the slopes to stabilize and bring it under Dam Safety requirements

6.1. Groundwater monitoring

During construction, downgradient monitoring wells will be sampled to evaluate any effects the cleanup action has on Site groundwater.

6.2. Institutional controls

Institutional controls are measures undertaken to limit or prohibit activities that may interfere with the integrity of a cleanup action or result in exposure to hazardous substances at the Site. Such measures are required to assure both the continued protection of human health and the environment and the integrity of the cleanup action whenever hazardous substances remain at the Site at concentrations exceeding applicable CULs. Institutional controls can include physical measures and legal and administrative mechanisms. WAC 173-340-440 provides information on institutional controls, and the conditions under which they may be removed.

The following institutional controls will be required, as incorporated into an environmental covenant to be filed with the Stevens County Auditor:

1. Stevens County shall enter into an access agreement with Ecology on the parcels of land that Stevens County holds as tax title lands at the Site. Ecology will work with Stevens County to develop an O&M plan which outlines the maintenance requirements of the cover system at the Lower Tailings Pile as well as access restrictions.
2. Weavers Professional Services shall provide a financial assurance mechanism to provide for the continued operation and maintenance of the cleanup action, which includes monitoring and maintaining institutional controls and operation and maintenance of the West End Pit Lake Dam, the cover system and access controls on the Lower Tailings Pile as well as the vegetative cover on the Waste Rock Area. Ecology will develop an O&M plan to meet these requirements.
3. Vaagen shall provide a financial assurance mechanism to provide for the continued operation and maintenance of the cleanup action, which includes monitoring and maintaining institutional controls and operation and maintenance of the West End Pit Lake Dam as well as the vegetative cover on the Waste Rock Area. Ecology will develop an O&M plan to meet these requirements.
4. Daniel Paul Sr. shall provide a financial assurance mechanism to provide for the continued operation and maintenance of the cleanup action, which includes monitoring and maintaining institutional controls and operation and maintenance of the West End Pit Lake Dam as well as the vegetative cover on the Waste Rock Area. Ecology will develop an O&M plan to meet these requirements.
5. An environmental covenant will be recorded for parcels within the Site in accordance with the Uniform Environmental Covenants Act (Chapter 64.70 RCW).

6.3. Financial assurances

WAC 173-340-440 states that financial assurance mechanisms shall be required at sites where the selected cleanup action includes engineered and/or institutional controls. Financial assurances will be required of Vaagen, Weavers Professional Services and Daniel Paul Sr. to provide for the continued operation and maintenance of the cleanup action, which includes monitoring and maintaining institutional controls and operation and maintenance of the West End Pit Lake Dam, the vegetative cover on the Waste Rock Area and the cover system on the Lower Tailings Pile.

6.4. Periodic review

As long as CULs have not been achieved, WAC 173-340-420 states that at sites where a cleanup action requires an institutional control, a periodic review shall be completed no less frequently than every five years after the initiation of a cleanup action. Additionally, periodic reviews are required at sites that rely on institutional controls as part of the cleanup action.

Since the waste materials remain on-site and institutional controls will be required, Ecology will complete periodic reviews at this Site. Groundwater monitoring data shall be reviewed to continue to assess the effectiveness of the cover system. If groundwater or surface water data do not indicate that the cover system is adequately addressing contamination to concentrations below CULs, then further remedial action may be considered.

7. References

GeoEngineers, 2017. *Van Stone Mine Feasibility Study*. Prepared for Washington State Department of Ecology, GeoEngineers, May 2, 2017.

Hart Crowser, 2012a. *Work Plan for Emergency Remedial Action, Upper Tailings Pile, Van Stone Mine*. Prepared for Washington State Department of Ecology, Hart Crowser 17800-34, October 15, 2012.

Hart Crowser, 2012b. *Emergency Remedial Action Construction Completion Report, Upper Tailings Pile, Van Stone Mine*. Prepared for Washington State Department of Ecology, Hart Crowser 17800-34, December 26, 2012.

Hart Crowser, 2013. *Van Stone Mine Remedial Investigation*. Prepared for Washington State Department of Ecology, Hart Crowser 17800-00, November 2013.

MacDonald, D., C. Ingersoll, and T. Berger, 2000. *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*. Archives of Environmental Contamination and Toxicology, Vl. 39, pp 20–31.

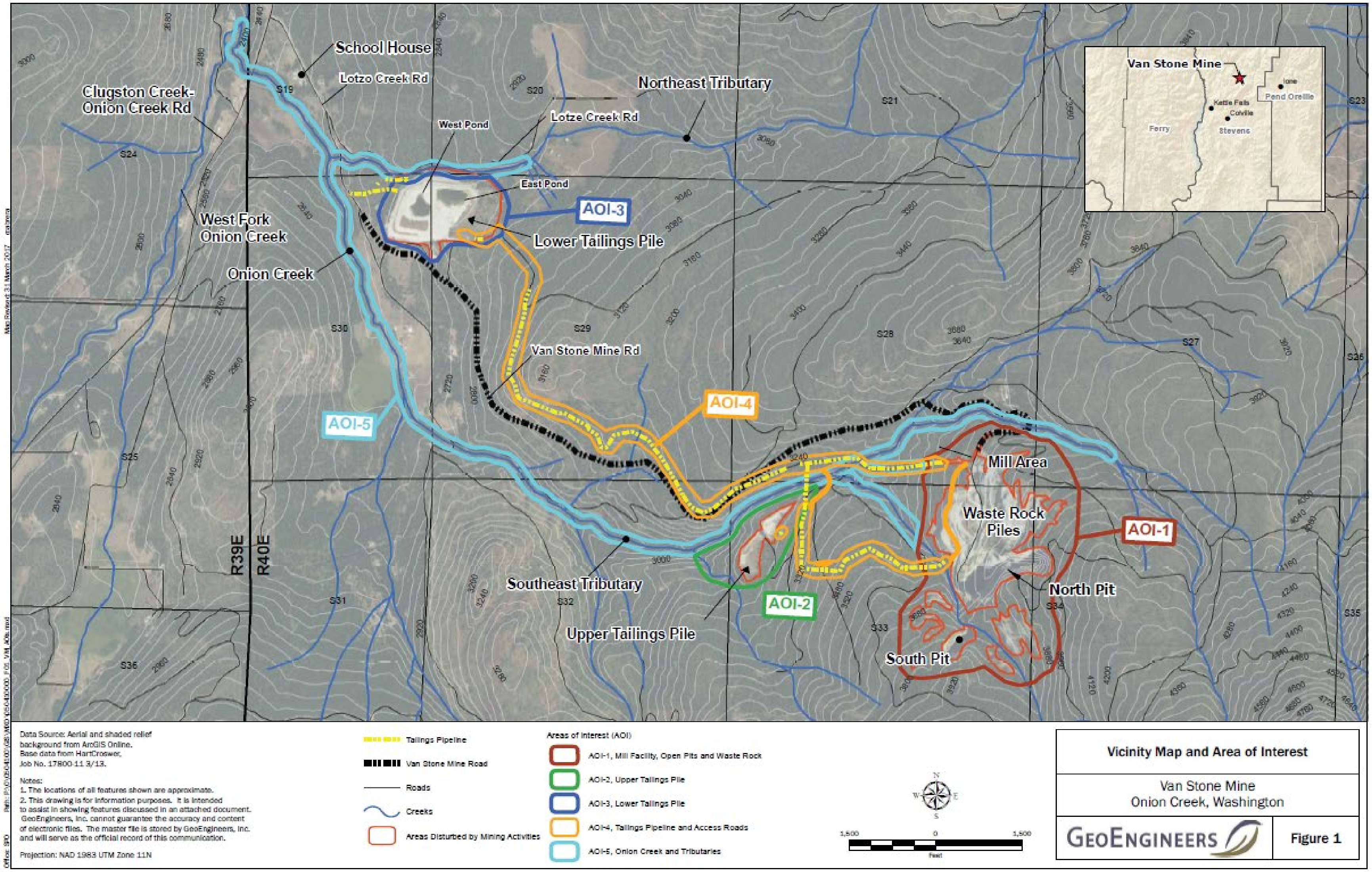
Washington State Department of Ecology, 2013. *Sediment Management Standards*. Publication No. 13-09-055.

Washington State Department of Natural Resources, 2005. *Inactive and Abandoned Mine Lands – Van Stone Mine, Northport Mining District, Stevens County, Washington*. Washington Division of Geology and Earth Resources Information Circular 100. December 2005.

Appendix A. Figures

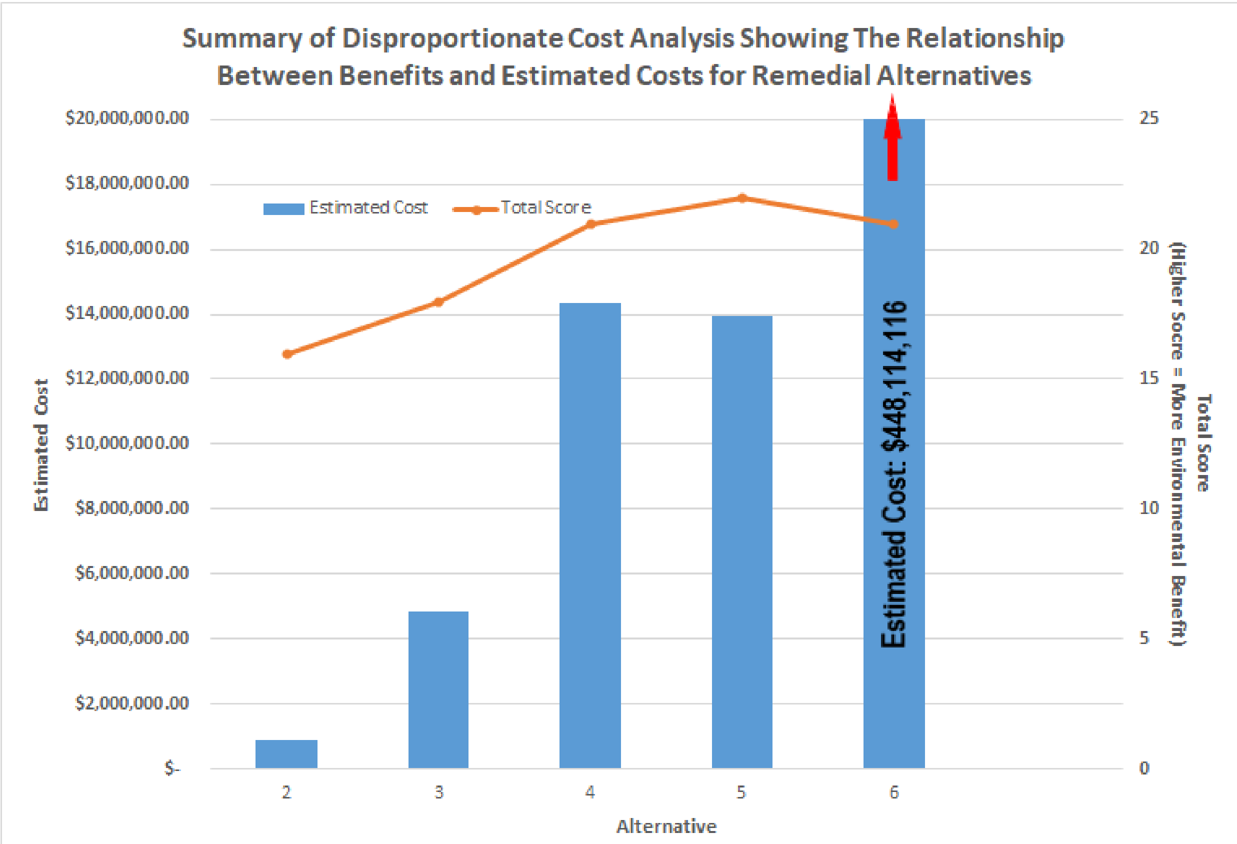
A.1. Area map

A.2. Site map



School House
Lotzo Creek Rd
Clugston Creek-Onion Creek Rd
Northeast Tributary
West Pond
Lotze Creek Rd
East Pond
AOI-3
Lower Tailings Pile
West Fork Onion Creek
Onion Creek
Van Stone Mine Rd
AOI-4
AOI-5
Mill Area
Waste Rock Piles
AOI-1
North Pit
Southeast Tributary
AOI-2
Upper Tailings Pile
South Pit
R39E
R40E
Van Stone Mine
Ione
Pend Oreille
Kettle Falls
Colville
Ferry
Stevens
Data Source: Aerial and shaded relief background from ArcGIS Online.
Base data from HartCrowser, Job No. 17800-11 3/13.
Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Projection: NAD 1983 UTM Zone 11N
Tailings Pipeline
Van Stone Mine Road
Roads
Creeks
Areas Disturbed by Mining Activities
Areas of Interest (AOI)
AOI-1, Mill Facility, Open Pits and Waste Rock
AOI-2, Upper Tailings Pile
AOI-3, Lower Tailings Pile
AOI-4, Tailings Pipeline and Access Roads
AOI-5, Onion Creek and Tributaries
1,500
0
1,500
Feet
Vicinity Map and Area of Interest
Van Stone Mine
Onion Creek, Washington
GeoEngineers
Figure 1

A.3. Disproportionate cost analysis



Appendix B. Tables

B.1. Applicable, relevant, and appropriate requirements (ARARs)

Action	Reference	Regulation Title
Cleanup Construction	29 CFR 1910	Occupational Safety and Health Act
	Ch. 296-155 WAC	Safety Standards for Construction Work
	Ch.296-62 WAC	Occupational Health Standards - Hazardous Waste Operations and Emergency Response
	Ch. 43.21 RCW; 197-11 WAC	State Environmental Policy Act and Rules
	33 USC 1251	Clean Water Act
	Ch. 173-340 WAC	Model Toxics Control Act
	Ch. 173-160 WAC	Minimum Standards for Construction of Wells
	40 CFR 257	Classification of Solid Waste Disposal Facilities and Practices
	Ch. 173-350 WAC	Solid Waste Handling Standards
	42 USC 7401; 40 CFR 50	Clean Air Act; National Ambient Air Quality Standard
	Ch. 173-175 WAC	Dam Safety
Cleanup Standards	42 USC 300	Safe Drinking Water Act
	40 CFR 141	National Primary Drinking Water Standards
	40 CFR 142	National Secondary Drinking Water Standards
	70.105D RCW; Ch. 173-340 WAC	Hazardous Waste Cleanup; Model Toxics Control Act
	40 CFR 131	National Toxics Rule
	Ch 90.48 RCW; 173-201A WAC	Water Pollution Control; Surface Water Quality Standard
	Ch. 246-290 WAC	Department of Health Standards for Public Water Supplies

B.2. Soil cleanup levels

Contaminant	Protection of Groundwater	Protection of Groundwater through Surface Water	Terrestrial Ecological Protection	Method B Human Health[1]	Background	Cleanup Level	Max Concentration	Number of Samples	Frequency of Detection	Frequency of Exceedance	Indicator?	Basis
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	-	-	-	-	-
Antimony[2]	5.4	51	**5**	32	0.86	5	20.0	220	0.87	0.02	Yes	Eco
Arsenic	2.9	-	10	**0.67**	5.04	5.04	26.5	226	0.99	0.61	Yes	Background
Beryllium	63	-	**10**	160	0.71	10	1.9	161	0.64	0	No	< Cleanup Level
Cadmium	**0.69**	-	4	80	1.60	1.60	215	226	0.99	0.45	Yes	Background
Chromium[3]	480,000	1,500	**42**	120,000	15.8	42	35.0	220	0.82	0.17	No	< Cleanup Level
Copper	280	**4.9**	50	3,200	12.7	12.7	640	226	0.86	0.26	Yes	Protection of GW→SW
Lead	3000	500	**50**	-	44.9	50	26,000	226	1.00	0.49	Yes	Eco
Mercury	2.1	**0.013**	0.1	2	0.13	0.13	2.80	220	0.91	0.27	Yes	Background
Nickel	420	-	**30**	1,600	13.1	30	45.0	220	0.84	0.005	No	<5% Exceedance
Selenium	5.2	-	**0.3**	400	1.65	1.65	2.3	161	0.80	0.006	Yes	Background
Silver	14	-	**2**	400	0.12	2	3.6	161	0.99	0.02	Yes	Eco
Thallium	**0.23**	-	1	0.8	0.2	0.23	1.3	161	0.40	0.19	Yes	Method B
Zinc	6,000	120	**86**	24,000	206	206	57,200	226	0.96	0.53	Yes	Background

Bold = Lowest screening level prior to adjustment for background

[1]MTCA Method B unrestricted land use soil cleanup standards. For carcinogenic constituents, the value presented is the lower of the non-carcinogenic and carcinogenic levels.

[2]The antimony cleanup value will be adjusted downward to the background value of 0.86 mg/kg to reduce the overall site risk. See Table B.13.

[3]Chromium values are listed as the trivalent form (chromium III), as the hexavalent form was not detected in soil.

Eco = terrestrial ecological protection
GW = groundwater
mg/kg = milligrams per kilogram
SW = surface water

B.3. Surface water cleanup levels

Contaminant	Laboratory MDL	MTCA Method B Protection of Human Health[2]	WAC 173-201A – Protection of Human Health	CWA Protection of Human Health	National Toxics Rule Protection of Human Health	WAC 173-201A – Protection of Aquatic Organisms - Acute	WAC 173-201A – Protection of Aquatic Organism - Chronic	Clean Water Act Protection of Aquatic Organisms - Acute	Clean Water Act Protection of Aquatic Organisms - Chronic	National Toxics Rule Protection of Aquatic Organisms - Acute	National Toxics Rule Protection of Aquatic Organisms - Chronic	Cleanup Level	Max. Concentration	Number of Samples	Frequency of Detection	Frequency of Exceedance	Indicator?	Basis
Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	-	-	-	-	-
Antimony	2	1000	12	**5.6**	6	-	-	-	-	-	-	5.6	13.0	29	0.59	0.03	Yes	CWA
Cadmium	0.14	41	-	-	-	7.42	1.66	3.27	**1.16**	7.42	1.66	1.16	4.2	29	0.21	0.07	Yes	CWA
Copper	0.55	2900	1,300	1300	-	31.1	**19.6**	-	-	31.1	19.6	19.6	10.0	29	0.14	0	No	< Cleanup Level
Lead	0.17	-	129	-	-	129	**5.02**	129	5.02	129	5.02	5.02	17	29	.24	0.1	Yes	WAC 173-201A
Mercury	0.0005	-	2.1	-	-	2.1	**0.012**	1.4	0.77	2.1		0.012	0.0009	26	0.58	0	No	< Cleanup Level
Nickel	2	1100	150	610	80	1391	155	464	**52**	1403	156	52	3.9	29	0.03	0	No	< Cleanup Level
Zinc	4.4	1700	2300	7400	1000	197	**180**	202	204	197	180	180	720	29	0.86	0.1	Yes	WAC 173-201A

Bold = Lowest screening level

[1]For hardness dependent metals, the site-specific hardness of 190 $CaCO_3$ (calcium carbonate) was used to develop their respective cleanup values.
[2]MTCA Method B groundwater cleanup standards. For carcinogenic constituents, the value presented is the lower of the non-carcinogenic and carcinogenic levels.

CWA = Clean Water Act
µg/L = micrograms per liter
MDL = minimum detection limit
MTCA = Model Toxics Control Act
WAC = Washington Administrative Code

B.4. Groundwater cleanup levels

Contaminant	Laboratory MDL	Federal MCLGoal	Federal MCL	State MCL	MTCA Cancer Risk at MCL	MTCA Hazard Quotient at MCL	Is MCL Protective?	Adjusted MCL	Method B Human Health – Carcinogenic	Method B Human Health - Noncarcinogenic	State Secondary MCL	Protection of Surface Water	Background	Cleanup Level	Max. Concentration	Number of Samples	Frequency of Detection	Frequency of Exceedance	Indicator?	Basis
Units	µg/L	µg/L	µg/L	µg/L	-	-	-	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	-	-	-	-	-
Antimony	0.4	6	6	**6**	-	0.09	Yes	-	-	6.4	-	-	-	6	28	27	0.15	0.04	Yes	MCL
Arsenic	3.8	0	10	**10**	1.72E-4	-	No	0.058	**0.058**	4.8	-	-	5	5	15	27	0.3	0.07	Yes	Background
Beryllium	0.51	4	4	**4**	-	0.13	Yes	-	-	32	-	-	-	4	1.8	14	0.21	0.0	No	< Cleanup Level
Cadmium	0.14	5	5	**5**	-	0.63	Yes	-	-	8	-	1,160	-	5	9.5	27	0.52	0.04	No	< 5% Exceedance
Chromium	1.4	100	100	**100**	-	0.00	Yes	-	-	24,000	-	-	-	100	48	14	0.57	0.07	No	< Cleanup Value
Copper	0.55	1,300	1,300	1,300	-	2.03	No	640	-	**640**	-	-	-	640	4.8	14	0.93	0.0	No	< Cleanup Value
Lead	0.17	0	15	**15**	-	-	-	-	-	-	-	5,020	5	15	220	27	0.67	0.07	Yes	MCL
Mercury	0.041	2	2	**2**	-	-	-	-	-	-	-	-	-	2	0.56	14	0.21	0.0	No	< Cleanup Level
Nickel	2	-	-	-	-	-	-	-	-	**320**	-	-	-	320	310	27	0.44	0.04	No	< Cleanup Level
Silver	0.15	-	-	-	-	-	-	-	-	**80**	100	-	-	80	42	14	0.36	0.0	No	< Cleanup Level
Thallium	**1.4**	0.5	2	2	-	12.5	No	0.16	-	0.16		-	-	1.4	1.4	27	0.04	0.04	No	< Cleanup Level
Zinc	4.4		-	-	-	-	-	-	-	**4,800**	5,000	155,000	-	4,800	390	14	1.0	0.0	No	< Cleanup Level

Bold = Lowest screening level prior to adjustment for background

MCL = maximum contaminant level
µg/L = micrograms per liter
MDL = minimum detection limit
MTCA = Model Toxics Control Act
WAC = Washington Administrative Code

B.5. Sediment cleanup levels

Contaminant	MacDonald et al 2000 PEC	SMS CSL[1]	Method B Soil – Human Health and Ecological Protection[2]	Background	Cleanup Level	Max. Concentration	Number of Samples	Frequency of Detection	Frequency of Exceedance	Indicator?	Basis
Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	-	-	-	-	-
Antimony	-	-	**5**	0.59	5	0.93	21	1.00	0.14	No	< Cleanup Level
Arsenic	33	120	**0.67**	6.66	6.66	7.8	21	1.00	0.05	No	< 5% Exceedance
Beryllium	-	-	**10**	0.74	10	0.44	21	0.86	0	No	< Cleanup Level
Cadmium	4.98	5.4	**4**	0.43	4	4.5	21	0.95	0.05	No	< 5% Exceedance
Chromium	111	88	**42**	14.3	42	7.3	21	1.00	0	No	< Cleanup Level
Copper	149	1,200	**50**	3.05	50	4.5	21	0.95	0	No	< Cleanup Level
Lead	128	>1,300	**50**	5.7	50	110	21	1.00	0.19	Yes	Method B
Mercury	1.06	0.8	**0.1**	0.0071	0.1	0.052	21	0.95	0	No	< Cleanup Level
Nickel	48.6	110	**30**	5	30	6.4	21	1.00	0	No	< Cleanup Level
Selenium	-	>20	**0.3**	0.52	0.52	0.82	21	0.71	.09	Yes	Background
Silver	-	**1.7**	2	0.02	1.7	0.068	21	0.95	0	No	< Cleanup Level
Thallium	-	-	**0.8**	.41	0.8	0.26	21	0.14	0	No	< Cleanup Level
Zinc	459	>4,200	**86**	33.5	86	910	21	0.95	0.86	Yes	Method B

Bold = Lowest screening level prior to adjustment for background

[1] SMS values were used when a PEC was not available.
[2] Method B Soil values are the lowest of either Method B values for the protection of human health in soil or terrestrial ecological protection from Table B.2.

CSL = cleanup screening level
mg/kg = milligrams per kilogram
PEC = probable effect concentration
SMS = Sediment Management Standards

B.6. Summary of indicator screening by media type

Contaminant	Soil	Surface Water	Groundwater	Sediment
Antimony	Indicator	Indicator	Indicator	-
Arsenic	Indicator	-	Indicator	-
Beryllium	-	-	-	-
Cadmium	Indicator	Indicator	-	-
Chromium	-	-	-	-
Copper	Indicator	-	-	-
Lead	Indicator	Indicator	Indicator	Indicator
Mercury	Indicator	-	-	-
Nickel	-	-	-	-
Selenium	Indicator	-	-	Indicator
Silver	Indicator	-	-	-
Thallium	Indicator	-	-	-
Zinc	Indicator	Indicator	-	Indicator

B.7. Cancer risk and hazard quotient calculations – soil

Indicator Substance	Proposed Cleanup Level (mg/kg)	Basis	Cancer Risk	Hematologic	Urinary	Dermal	Nervous	Cardiovascular	Not Specified
Antimony	5	Eco	-	1.56E-01	-	-	-	-	-
Arsenic	5.04	Background	NCb	-	-	NCb	-	NCb	-
Cadmium	1.60	Background	-	-	NCb	-	-	-	-
Copper	12.7	Protection of GW→SW	-	-	-	-	-	-	3.97E-03
Lead	50	Eco	-	-	-	-	-	-	NCt
Mercury	0.13	Background	-	-	-	-	-	-	NCb
Selenium	1.65	Background	-	NCb	-	NCb	NCb	-	-
Silver	2	Eco	-	-	-	5.00E-03	-	-	-
Thallium	0.23	Method B	-	-	-	-	-	-	2.88E-01
Zinc	206	Background	-	NCb	-	-	-	-	-
Total	**-**	**-**	**0**	**1.56E-01**	**0**	**5.00E-03**	**0**	**0**	**2.91E-01**

- = Not associated with toxicological endpoint

NCb = Not calculated as the cleanup level is based upon background

NCt = Not calculated as no toxicological reference data available

B.8. Cancer risk and hazard quotient calculations – soil (adjusted)

Indicator Substance	Proposed Cleanup Level (mg/kg)	Basis	Cancer Risk	Hematologic	Urinary	Dermal	Nervous	Cardiovascular	Not Specified
Antimony	0.86	Background	-	NCb	-	-	-	-	-
Arsenic	5.04	Background	NCb	-	-	NCb	-	NCb	-
Cadmium	1.60	Background	-	-	NCb	-	-	-	-
Copper	12.7	Protection of GW→SW	-	-	-	-	-	-	3.97E-03
Lead	50	Eco	-	-	-	-	-	-	NCt
Mercury	0.13	Background	-	-	-	-	-	-	NCb
Selenium	1.65	Background	-	NCb	-	NCb	NCb	-	-
Silver	2	Eco	-	-	-	5.00E-03	-	-	-
Thallium	0.23	Method B	-	-	-	-	-	-	2.88E-01
Zinc	206	Background	-	NCb	-	-	-	-	-
Total	**-**	**-**	**0**	**0**	**0**	**5.00E-03**	**0**	**0**	**2.91E-01**

- = Not associated with toxicological endpoint

NCb = Not calculated as the cleanup level is based upon background

NCt = Not calculated as no toxicological reference data available

B.9. Cancer risk and hazard quotient calculations – surface water

Indicator Substance	Proposed Cleanup Level (µg/L)	Basis	Cancer Risk	Hematologic	Urinary	Dermal	Nervous	Cardiovascular	Not Specified
Antimony	5	CWA	-	3.38E-04	-	-	-	-	-
Cadmium	1.60	CWA	-	-	3.58E-03	-	-	-	-
Lead	50	WAC 173-201A	-	-	-	-	-	-	NCt
Zinc	206	WAC 173-201A	-	6.80E-04	-	-	-	-	-
Total	**-**	**-**	**0**	**1.02E-03**	**3.58E-03**	**0**	**0**	**0**	**0**

- = Not associated with toxicological endpoint

NCb = Not calculated as the cleanup level is based upon background

NCt = Not calculated as no toxicological reference data available

B.10. Cancer risk and hazard quotient calculations – groundwater

Indicator Substance	Proposed Cleanup Level (µg/L)	Basis	Cancer Risk	Hematologic	Urinary	Dermal	Nervous	Cardiovascular	Not Specified
Antimony	5	MCL	-	9.38E-01	-	-	-	-	-
Arsenic	5.04	Background	NCb	-	-	NCb	-	NCb	-
Lead	50	MCL	-	-	-	-	-	-	NCt
Total	**-**	**-**	**0**	9.38E-01	**0**	**0**	**0**	**0**	**0**

- = Not associated with toxicological endpoint

NCb = Not calculated as the cleanup level is based upon background

NCt = Not calculated as no toxicological reference data available

B.11. Cancer risk and hazard quotient calculations – sediment

Indicator Substance	Proposed Cleanup Level (mg/kg)	Basis	Cancer Risk	Hematologic	Urinary	Dermal	Nervous	Cardiovascular	Not Specified
Lead	50	Method B	-	-	-	-	-	-	NCt
Selenium	1.65	Background	-	NCb	-	NCb	NCb	-	-
Zinc	206	Method B	-	3.58E-03	-	-	-	-	-
Total	**-**	**-**	**0**	**3.58E-03**	**0**	**0**	**0**	**0**	**0**

- = Not associated with toxicological endpoint

NCb = Not calculated as the cleanup level is based upon background

NCt = Not calculated as no toxicological reference data available

B.12. Overall site cancer risk and hazard quotient calculations

Media	Cancer Risk	Hematologic	Urinary	Dermal	Nervous	Cardiovascular	Not Specified
Soil	-	1.56E-01	-	5.00E-03	-	-	2.91E-01
Surface Water	-	1.02E-03	3.58E-03	-	-	-	-
Groundwater	-	9.38E-01	-	-	-	-	-
Sediment	-	3.58E-03		-	-	-	-
Total	**0**	**1.10E+00**	**3.58E-03**	**5.00E-03**	**0**	**0**	**2.91E-01**

B.13. Overall site cancer risk and hazard quotient calculations – adjusted

Media	Cancer Risk	Hematologic	Urinary	Dermal	Nervous	Cardiovascular	Not Specified
Soil	-	-	-	5.00E-03	-	-	2.91E-01
Surface Water	-	1.02E-03	3.58E-03	-	-	-	-
Groundwater	-	9.38E-01	-	-	-	-	-
Sediment	-	3.58E-03		-	-	-	-
Total	**0**	**9.42E-01**	**3.58E-03**	**5.00E-03**	**0**	**0**	**2.91E-01**

B.14. Cleanup alternative evaluation

	Alternative 2	**Alternative 3**	**Alternative 4**	**Alternative 5 (Selected Cleanup)**	**Alternative 6**
Compliance with MTCA Threshold Requirements	No	Yes	Yes	Yes	Yes
Provide for a Reasonable Restoration Time Frame	Low	Medium	Medium	High	High
Protectiveness	2	3	4	4	5
Permanent Reduction	1	2	3	4	5
Long-Term Effectiveness	2	3	4	4	5
Short-Term Risk	5	4	3	3	1
Implementability	5	4	3	3	2
Consider Public Concerns	1	2	4	4	3
Total of Scores	**16**	**18**	**21**	**22**	**21**
Cleanup Cost (estimated $)	$903,400	$4,863,076	$14,361,469	$13,960,482	$448,143,116

Note: Relative benefits ranking (scored from 1 = lowest to 5 = highest)