Ballard Mine Proposed Plan

Caribou County, Idaho

APRIL 2018

U.S. Environmental Protection Agency, Region 10

Proposed Plan for Public Comment

Introduction

The U.S. Environmental Protection Agency (EPA) is proposing a plan for the cleanup of the Ballard Mine Site (Site) in Caribou County, Idaho, and is inviting the public to review and comment on the Proposed Plan. The Site is a former phosphate mine located in the Phosphate Resource Area of Southeast Idaho (See Figure 1). Operation of the mine resulted in the contamination of upland soils, surface water, riparian sediments/soils, and groundwater with metalloids (for example, arsenic, and selenium), metals, and uranium daughter products (for example, radium and radon).

This Proposed Plan provides background information on the Site and the cleanup process, describes the cleanup alternatives that were evaluated, identifies EPA's preferred cleanup alternative, and explains the reasons for this preference. The topics covered by this Proposed Plan are shown in the inset box below.

Inside this Proposed Plan:

- The Superfund Process
- Site Background
- Site Characteristics
- Scope and Role of the Proposed Action
- Summary of Site Risks
- Remedial Action Objectives and Goals
- Summary of Remedial Alternatives
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- Figures

Public Comment Period: April 2018

EPA will accept comments on the Proposed Plan during the public comment period (April 2, 2018 to May 1, 2018). Comments may be submitted three ways. (See Community Involvement Section for more details).

1. By Mail:

   Attn: Ballard Mine Comments
   Kay Morrison

   USEPA REGION 10
   1200 Sixth Ave., Suite 900
   Mail Code: RAD-202-3
   Seattle, WA 98101

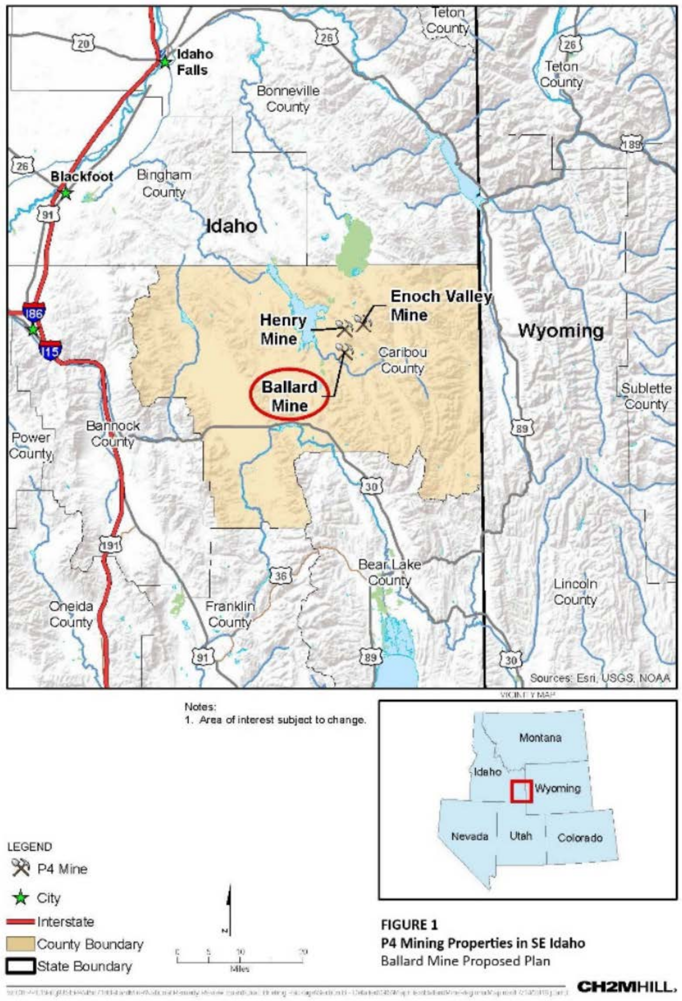
2. By E-mail: morrison.kay@epa.gov
3. During Public Meetings:
   - EPA will hold a public meeting on April 11, 2018 at the City Hall in Soda Springs, Idaho (see our website at epa.gov). The meeting will consist of:

     Open House 3:00 to 5:45 PM

     Public Hearing 6:00 to 8:00 PM
   - EPA will present the Proposed Plan. There will be an opportunity to provide written or oral comments during this meeting.
   - Other reminders of the public meeting will be placed in a fact sheet to stakeholders, and ads in the local newspapers. You can find links to the Proposed Plan and supporting documents in the Administrative Record on our website.

Figure 1. Project Location

Site location map shows the Ballard Mine location in Caribou County in the southeast corner of Idaho, within roughly 20 miles of the Wyoming border and 50 miles of the Utah border. The Ballard Mine is immediately south of the Henry Mine and southwest of the Enoch Valley Mine.



A Proposed Plan is a document that EPA is required to issue under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), also known as Superfund, and the regulations that implement CERCLA, known as the National Contingency Plan (NCP). By issuing the Proposed Plan, EPA fulfills the statutory and regulatory requirements of CERCLA § 117(a) and the NCP § 300.430(f)(2).

The Proposed Plan is based on information collected, evaluated, and summarized in reports prepared by P4 Production LLC (P4, a subsidiary of Monsanto), with direction and oversight provided by EPA, the lead agency, and several support agencies, including Idaho Department of Environmental Quality (DEQ), the U.S. Fish and Wildlife Service (USFWS), and the Shoshone-Bannock Tribes.

This Proposed Plan highlights key information from the remedial investigation (RI) and feasibility study (FS) reports. The reader should consult the RI/FS reports and documents in the administrative record for more information regarding the proposed remedial action.

EPA is inviting input and new information from the public on all alternatives and on the rationale for the Preferred Alternative. After considering public comments, EPA will issue a Record of Decision (ROD) that selects a final remedy to be implemented. The Support Agencies will be consulted in the selection of a final remedy.

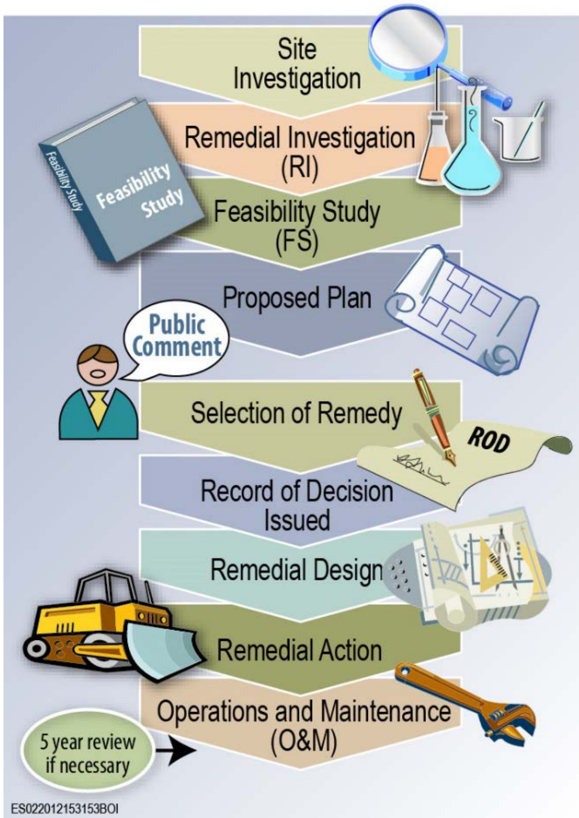
Information on how to provide comments or questions to EPA is presented in the inset on page 1 and on page 39.

A list of environmental terms and abbreviations used in this Proposed Plan, along with referenced project Attachments A and B, are provided at the end of the document.

The Superfund Process

The Superfund process is a structured process, established by CERCLA and the NCP, to guide the cleanup of contaminated sites. The process includes various steps, illustrated in Figure 2, leading from discovery of a site, through investigation, remedy selection, and implementation of a remedy. The NCP includes procedures, expectations, and program management principles to guide the process. In addition, EPA has developed technical guidance and policy on a range of issues so that decisions are based on sound science and to ensure that cleanup actions will ultimately be protective of human health and the environment.

Figure 2. Steps in the Superfund Cleanup Process



The work at the Ballard Mine Site is following this process. The steps of the process that have been completed so far include site investigations and development of RI/FS reports.

- *Ballard Mine Remedial Investigation Report.* This report, completed in 2014, contains a description of the Site, a characterization of the nature and extent of contamination, and findings of the human health and ecological risk assessments.
- *Ballard Mine Feasibility Study*. This report, completed in 2017, screens potential remedial options, identifies the most viable remedial alternatives and evaluates the alternatives using nine EPA criteria (see Inset Box on page 27).

The Ballard Mine Proposed Plan initiates the next phase of the Superfund process by presenting to the public the alternatives evaluated in the FS, identifying a preferred alternative, and soliciting comments. The key elements of the Preferred Alternative are shown in the Inset Box below. The public comments are an important part of the process and will be considered in the final evaluation of alternatives.

The Preferred Alternative Will:

Control the primary source of contamination—the waste rock dumps—by constructing a thick cover of soil and vegetation (evapotranspiration, or ET cover).

Prevent water from moving down into the waste rock and contaminating groundwater or creating seeps with an ET cover.

Include mining of remaining phosphate ore from the Site during implementation of the remedy. Re-mining of portions of the site is contingent on BLM issuing a mineral lease and approving a mine plan for extraction of ore. The mining activities will generate additional material for backfill of mine pits and construction of the ET cover.

Capture contaminated seepage along the fringe of waste rock dumps and treat it using constructed wetlands to remove contaminants.

Trap sediment in retention basins downgradient of waste rock areas and monitor nearby ephemeral and intermittent streams to confirm that contaminant concentrations are decreasing over time due to natural processes.

Intercept and treat shallow alluvial groundwater using permeable reactive barriers (PRBs) designed to remove contaminants.

Monitor the levels of contaminants in groundwater over time to confirm that source controls and treatment combined with recharge and natural processes are decreasing contaminant concentrations over time.

Defer selection of a final remedy for the Ballard Shop area while that area remains in use.

Apply institutional controls (IC) to ensure the integrity of the remedy and to prevent human exposure until the remedy is fully operational and functioning successfully.

After evaluating input and any new information provided during the public comment period, EPA will issue a ROD, likely in 2018. The ROD will select a remedy and explain the rationale for this decision. The ROD will also include responses to public comments in a section known as the Responsiveness Summary.

Following issuance of a ROD, EPA will negotiate a legal agreement with the parties responsible for the contamination (P4) to design and implement the remedy. P4 will then design and implement the remedy with oversight from EPA and the Support Agencies.

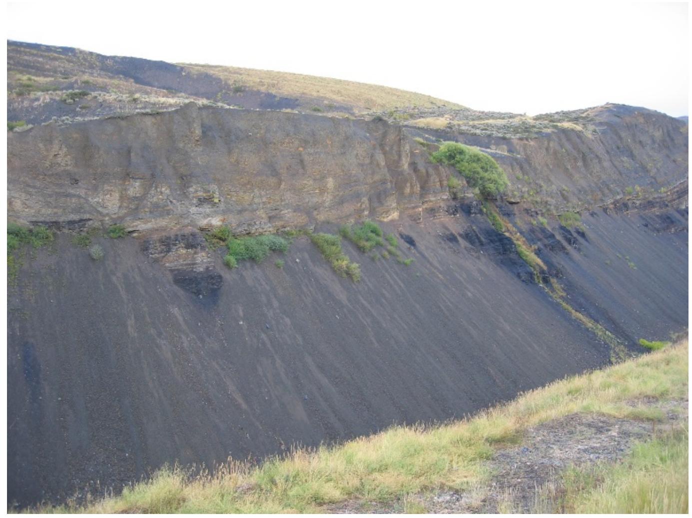
A robust operations and maintenance (O&M) program will be implemented post-construction to ensure the integrity of the remedy. The O&M program will be complimented by a comprehensive monitoring program and 5-year review process to provide ongoing evaluation of the effectiveness of the remedy and facilitate improvements should they be necessary.

Site Background

The Site is a former open-pit phosphate mine located in the Phosphate Resource Area of southeast Idaho. This is an area where phosphate-rich sedimentary rock units are present near the surface and have been mined for more than 70 years. There are many historical mines within the mining district, four active mines, and a number of proposed mines.

The Site is located about 13 miles north-northeast of Soda Springs, Idaho, in Caribou County. The Ballard Mine was operated by Monsanto from 1951 to 1969 and includes approximately 534 acres of mining disturbance, consisting of six open pits, six external waste rock dumps, an abandoned haul road, and the Ballard Shop area. Most of the Site has been revegetated, with the exception of some mine pit areas and steep waste rock dump slopes (see Figure 3).

Figure 3. Ballard Mine Pit



No ore processing occurred at the Site. Ore was hauled by truck to Monsanto's processing plant near the town of Soda Springs. The key features of the Site and land ownership are presented in Attachment A (located at the end of this document). Investigations to assess impacts of phosphate mining in southeast Idaho on human health and the environment increased after several horses (pastured in another part of the mining district) were diagnosed with selenosis (selenium poisoning) in 1996 and were subsequently euthanized. Some of these early studies were conducted by the U.S. Geological Survey (USGS) and the University of Idaho. Other investigations in the late 1990s were conducted under direction of the Idaho Mining Association's Selenium Subcommittee. These studies contributed to EPA's understanding of how phosphate mining may impact the environment.

In 2001, DEQ assumed leadership of an area-wide investigation of contamination from phosphate mining, with participation by other state and federal agencies and the mining companies with operations in southeast Idaho. These area-wide investigations led the agencies to conclude that site-specific investigations were warranted on the larger historic and active open-pit mines located in the mining district, including the Ballard Mine and others.

These conclusions subsequently led to negotiations with P4 to conduct site-specific investigations at the historical mines for which it is responsible. In October 2003, DEQ, EPA, U.S. Forest Service (USFS), the Shoshone-Bannock Tribes, Bureau of Indian Affairs, Bureau of Land Management (BLM), and P4 (the latter as Respondent) entered into a mine-specific legal agreement (EPA, 2003) calling for P4 to conduct investigations and develop site investigation (SI) and engineering evaluation/cost analyses (EE/CA) reports for the Ballard, Henry, and Enoch Valley Mine sites. DEQ was designated the lead agency to oversee this work. This work resulted in the collection of a considerable amount of information and a better understanding of site conditions.

In November 2009, a new legal agreement transitioned work at the P4 sites into a thorough “remedial” approach, and from DEQ lead to EPA lead. The 2009 agreement superseded the 2003 agreement and called for performance of an RI and FS at each of the three P4 mine sites. The 2009 agreement included EPA, DEQ, USFS, the Department of the Interior (for USFWS), BLM, the Shoshone-Bannock Tribes, and P4.

A variety of community involvement activities have occurred in conjunction with investigation and remedial activities of phosphate mine sites in Southeast Idaho since 2008. Results are included in a Community Involvement Plan (CIP). In 2009, the EPA interviewed area stakeholders including elected officials (such as mayors, city council members, and county commissioners); staff representatives for Senators Crapo and Risch and Representative Simpson; local legislative representatives; and area landowners and residents.

The EPA and support agencies completed the following public information activities specific to the P4 mines:

- Distributed one fact sheet and held one public information meeting in Soda Springs in 2008.
- Developed a display explaining the RI/FS process at the P4 Mines and Conda and installed it at the Soda Springs Library, City Hall, and Courthouse in 2011.
- Issued factsheets in 2012 and 2014. Hosted an open-house style community meeting in 2014.
- Provided updates on the P4 Mines in area-wide factsheets that were issued in 2012, 2014, and 2016.

Site Characteristics

Overview and Conceptual Site Model

The Site is located in a mountainous semi-arid region of southeastern Idaho. The topography of this area is dominated by north-northwest/south-southeast trending ridgelines of moderate relief, ranging in elevation from 6300 to 7000 feet. The Site is located on one such ridgeline, and is bounded to the east and west by three low-gradient drainage basins containing a number of intermittent or ephemeral streams that originate from, or flow past the Site (Long Valley Creek, Wooley Valley Creek) as tributaries to the Blackfoot River.

Topography at the Site is significantly altered by six mine pits, multiple large waste rock dumps, a primary haul road, and a shop area. Much of the mine area is vegetated, with the exception of some mine pit areas and steep waste-rock dump slopes.

The area disturbed by mining is owned by P4, or is State land for which P4 has a surface easement. Nearby adjoining lands are privately owned ranching and farming properties. The nearest federal land is a 40-acre BLM parcel about 1 mile from the Site. Attachment A shows land ownership at and near the site.

A conceptual site model was developed to show the relationship between the sources of contaminants at the Site, mechanisms for release of contaminants, and transport pathways to various environmental media (see Attachment B at the end of the document). The model provides a framework to assess risks from contaminants and develop cleanup strategies. The following information describes elements of the conceptual site model.

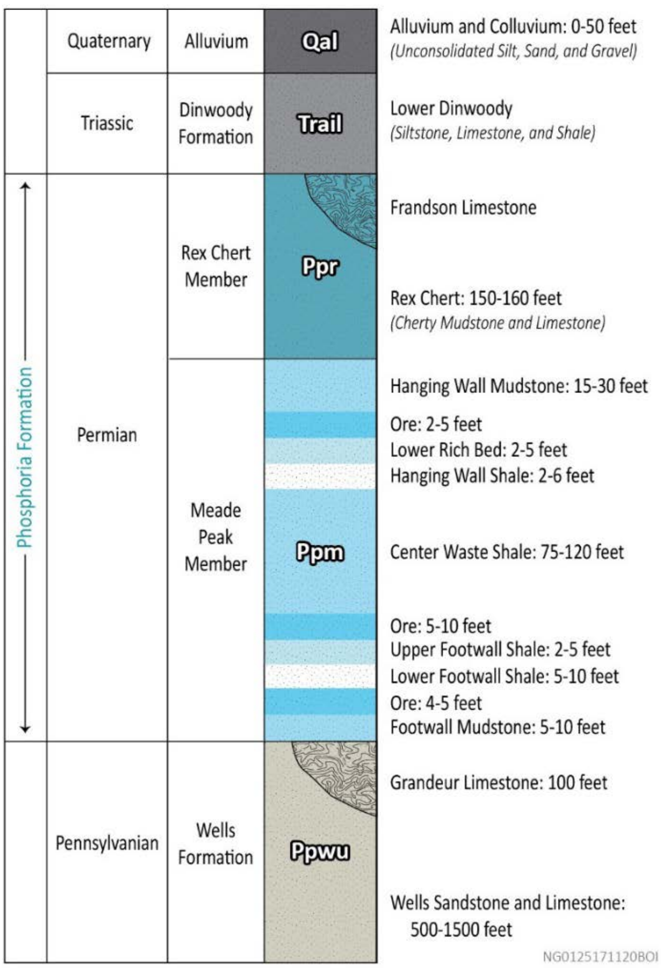
Sources of Contamination

The nature and extent of contamination associated with the Ballard Mine was investigated through review of background information that confirmed characteristics of the mined materials and mining practices, and extensive sampling of the various media within and downslope of the Site. The primary source of contaminants at the Site is waste rock located in mine pits and dumps, particularly shale material from the

Meade Peak Member of the Phosphoria Formation (Figure 4). This shale is enriched with selenium (a nonmetal) as well as metals, metalloids, and uranium daughter products (for example, radium and radon), and represents a significant portion of the waste rock stockpiled in waste rock dumps. Mine pit walls and roads associated with the Site represent minor source areas.

Another potential source area is the Ballard Shop area (see Attachment A). This is an area that continues to be used for equipment storage, fuel storage, stockpiling of slag material used as aggregate for active haul roads, and other activities. Investigations have identified the presence of organic contaminants, primarily fuel and solvent-related organic compounds, in soil and groundwater. As previously mentioned, selection of a final remedy for the Ballard Shop area will be deferred until this area is no longer in use. This proposed plan includes interim actions for the shop area, including institutional controls (IC).

Figure 4. Generalized Stratigraphic Column for the Phosphate Resource Area of Southeast Idaho.



Release and Transport

One of the key questions of interest of the RI was to better understand the release of contaminants from source areas and transport to other media. Release of mine-related constituents occurs as the result of dissolution or leaching (from contact with rain or snowmelt) of contaminants from center waste shales present in source areas, and the subsequent migration (movement) of dissolved constituents in surface water (runoff and seeps) and groundwater. There has also been erosion of contaminated particles from waste rock dumps, transport off the dump(s), and subsequent deposition in ephemeral and intermittent streams, resulting in impacts to both stream sediment and riparian soil downgradient of source areas. Evidence suggests that wind erosion and dispersion does not play a significant role in transporting contaminants. Attachment B illustrates conceptually, the relationships between source areas, release and transport mechanisms, and affected media.

Contaminant selenium is observed to have significant uptake into vegetation growing on waste rock dumps or in riparian areas adjacent to impacted stream channels. Generally, this occurs through the uptake from soil or waste rock through the root system and into plant tissue.

Media influenced and affected by mine waste and associated contaminants include:

- Upland soil, surface material/waste rock (18 million cubic yards)
- Riparian soil and sediment (approximately 5 acres of impacted stream channel sediments and riparian soil in Ballard Creek and Wooley Valley Drainages)
- Upland and riparian vegetation (secondary medium)
- Surface water (ephemeral and intermittent streams, ponds, seeps)
- Groundwater (alluvial, and regional bedrock aquifers)

The range of concentrations of risk-based contaminants at the Site are presented in Tables 1a and 1b. Background concentrations for the same contaminants are presented for comparison.

Table 1a. Data Summary for Media and Contaminants of Concern

Contaminant	Number of Samples	Maximum Concentration (mg/kg)	Minimum Concentration (mg/kg)	Mean Concentration (mg/kg)	Exposure Point Concentration[a] (mg/kg)	Background[b] (mg/kg)
Upland Soil						
Antimony	94	10.9	0.621	4.61	4.89	3.60
Arsenic	94	45.5	3.51	20.0	21.8	15.6
Cadmium	104	167	1.44	32.7	37.6	41.0
Chromium	104	594	0.600	230	327	410
Copper	104	174	6.80	69.8	87.2	51.9
Molybdenum	104	48.7	2.36	20.5	20.0	29.0
Nickel	104	635	4.80	186.5	205	220
Radium-226[c]	20	19.0	2.17	8.76	82.4	22.7
Selenium	130	209	0.120	38.0	53.5	29.0
Thallium	94	3.68	0.176	1.08	1.2	1.10
Uranium	94	87.1	1.10	29.8	38.3	36.0
Vanadium	104	808	1.06	200	239	300
Zinc	104	1,810	38.5	764	835	1,200
Riparian Soil						
Arsenic	14	8.91	1.83	4.47	5.83	5.93
Cadmium	44	131	0.440	16.7	25.4	7.24
Chromium	44	2,780	13.9	200	503	43.3
Copper	44	272	7.00	40.3	71.1	24.3
Molybdenum	44	48.6	0.330	9.34	16.4	0.653
Nickel	44	1,620	10.7	108	281	29.6
Selenium	44	570	0.700	34.5	89.5	2.03
Thallium	14	0.681	0.164	0.292	0.376	2.03
Vanadium	44	773	22.2	123	233	0.483
Sediment						
Antimony	7	6.60	4.60	5.88	6.05	5.00
Arsenic	7	13.4	3.33	6.06	13.0	4.55
Cadmium	32	138	0.550	19.6	42.1	4.17
Copper	7	70.6	13.2	29.0	51.1	25.5
Molybdenum	7	12.8	8.80	10.8	12.8	0.541
Selenium	32	1,300	0.600	120	208	1.48
Thallium	7	1.63	0.122	0.536	1.30	0.378
Vanadium	32	920	25.0	152	321	113
Upland Vegetation (All Plants)						
Arsenic	128	14.2	0.0750	0.806	1.42	–
Cadmium	129	4.54	0.0257	1.17	1.55	–
Selenium	160	366	0.304	26.2	39.7	–

Notes:

[a] An upper estimate (95%) of the mean used for calculation of Site risk. (EPC = the level of a chemical to which a receptor is potentially exposed)

[b] The 95-95 upper threshold limit was selected as the proposed background level for upland soils collected in 2009 and 2014. The 95-percent Upper Simultaneous Limit (USL) was selected as the proposed background level for sediment and riparian soil datasets collected in 2004 and 2010 (MWH 2013a, 2013b).

[c] Radium-226 are in picocuries per gram (pCi/g). (Source: On-site and Background Areas radiological and Soil Investigation Summary Report, October 2015)

mg/kg = milligram per kilogram

Table 1b. Data Summary for Media and Contaminants of Concern

Contaminant	Number of Samples	Maximum Concentration (mg/L)	Minimum Concentration (mg/L)	Mean Concentration (mg/L)	Background[b] (mg/kg)
Surface Water (Dissolved, all locations)					
Arsenic	63	0.0556	0.000500	0.0100	0.00109
Cadmium	184	0.00440	0.0000350	0.000837	0.00010
Selenium (Total)	187	2.84	0.000758	0.334	0.000772
Groundwater (Total)					
Arsenic	16	0.0267	0.000456	0.00491	0.00103
Cadmium	84	0.0215	0.000170	0.00333	0.000401
Selenium	148	3.20	0.000534	0.273	0.00278

Notes:
All concentrations are mg/L.
[b] Background concentration is equal to the 95% USL of background data set (MWH, 2013a).
mg/L = milligram per liter
USL = upper simultaneous limit

- In summary, site investigations show that waste rock in mine dumps and backfilled pits are the primary source of contaminants. The concentrations of contaminants in upland soil and waste rock are highly variable, and reflect the chemical composition of the types of waste rock located on the surface of the waste rock dumps. Waste rock produced during mining included shale, chert, and limestone, with the Center Waste Shale of the Phosphoria Formation containing the highest concentration of selenium and other contaminants.
- Investigations also show that contaminants have been released and transported from the waste rock source areas to other media. In surface water, sampling shows that the highest concentrations of selenium and other contaminants are typically found in seeps and intermittent streams close to the waste rock dumps on the margins of the Site. Concentrations decrease moving away from the source areas due to dilution and attenuation. In groundwater, sampling shows that the highest concentrations of selenium are found close to the waste rock dumps, in the alluvial aquifers on the margins of the Site, and in the bedrock aquifer in the southwest portion of the Site. Contaminant plumes in groundwater dissipate moving away from the source areas. With respect to sediment and riparian soil, sampling shows a similar pattern, with the most impacted areas close to the waste rock source areas, with contaminants found in and along intermittent stream corridors and dissipating moving downstream.
- No principal threat wastes have been identified at the Ballard site. Principal threat wastes are source materials considered to be highly toxic or highly mobile that generally cannot be contained in a reliable manner or present a significant risk to human health or the environment should exposure occur. The source materials are waste rock located in the mine dumps and backfilled pits at the Site. These source materials can be reliably contained through use of engineering controls (robust cover systems), complimented by long-term O&M and institutional controls to protect the cover system.

How People and Wildlife may be Exposed

Hikers or hunters can be exposed to contamination by dermal contact (touching); inhaling dust; ingesting water, contaminated soil, sediment, or vegetation; or by direct radiation (gamma rays emitted from contamination on the ground surface).

- Dermal (skin) contact (touching) can happen when contaminants from soil or dust adhere to skin or clothing.
- Incidental ingestion (swallowing) occurs when people, especially children, swallow soil that sticks to their skin or clothing.
- Inhalation (breathing) of soil dust occurs when fine particles are suspended in the air by wind or mechanical disturbance (for example, four-wheelers).
- Direct radiation can happen when people are exposed to material containing uranium decay

products (such as radium-226 or radon gas) that emit high-energy electro-magnetic-radiation (gamma rays).

Wildlife can be exposed by direct contact and by ingesting and inhaling soil and surface water impacted by the mine site. Certain vegetation, such as milk-vetch or asters, concentrate contamination (hyper-accumulate) through its root system. Animals that graze on hyper-accumulating vegetation growing on mine materials may be poisoned. Insects and amphibians, may be exposed to contaminated water and sediment in intermittent streams.

Current and Future Land Uses

The Ballard Site is located in a rural and sparsely populated area. The nearest town is Soda Springs, which is located about 13 miles away. Farming and seasonal ranching are the dominant land uses in the vicinity of the Site. There are many active and inactive phosphate mines in the area. The surrounding area is also used by the public for recreation, including hunting on private and public lands, and fishing on the Blackfoot Reservoir and Upper Blackfoot River.

The Ballard Site includes the former mine area and contaminated portions of adjacent properties. Currently, the former mine area is fenced and access is restricted. The mining haul road on the western edge of the Site is still used. Current land uses of the adjoining properties include dry-land farming and seasonal ranching (grazing of cattle). There is likely some limited recreational and Tribal use of the State lands at the Site as well. There are no residences at, or near, the Site.

The reasonably anticipated future uses of the land at the Site include agriculture, seasonal ranching (grazing of cattle and sheep), recreation, and Tribal use. Residential use of the Site is unlikely because of the remote site location, and accessibility to existing infrastructure. In addition, the Preferred Alternative envisions that mining will occur during implementation of the remedial action (contingent on BLM issuing a phosphate mineral lease and approving a mine plan for extraction of ore). It is anticipated that mining would end with completion of the remedy.

Scope and Role of the Proposed Plan

This Proposed Plan describes actions that address threats to human health and the environment posed by contaminants at the Site. This document is based on information and analyses that were prepared by P4 pursuant to an Administrative Settlement Agreement and Order on Consent/Consent Order (2009 CO/AOC). The 2009 CO/AOC includes the Ballard Mine Site, as well as the Henry Mine and Enoch Valley Mines. The mines are separated, but share similarities in mining features, contaminants of concern (COC), affected media, and exposure/transport pathways. P4 will prepare separate RI and FS reports for each of these mines. The Ballard Mine site is the first of the three to reach this stage of the Superfund process. The Ballard Mine is not listed on the National Priorities List (NPL). Cleanup is occurring under a voluntary agreement with the responsible party (P4).

The remedial alternatives for the Site include final actions for all areas of the site except the Ballard Shop area. Interim actions are proposed for the Ballard Shop area, including ICs and fencing. A separate Proposed Plan and ROD will be developed for this area when the shop is no longer needed.

This approach is consistent with EPA's goal of implementing cost-effective and protective (long-term) remedies that leave the Site in a stable configuration and ready for reuse, including grazing and recreation.

Summary of Site Risks

Human health and ecological baseline risk assessments were conducted to evaluate the risks to people and the environment from exposure to contaminants originating from the historic mining activities at the Ballard Mine.

A detailed description of site risks can be found in the Baseline Risk Assessment presented in Appendix A of the Ballard Mine *Remedial Investigation Report* (MWH, 2014a). Additional information relating to radiological risks can be found in the *Ballard Mine Remedial Investigation and Feasibility Study, Remedial Investigation Report, Baseline Risk Assessment Addendum* (MWH, 2015b) and *On-Site and Background Areas Radiological and Soil Investigation Summary Report* (MWH, 2014b). The range of concentrations of COCs are presented in Tables 1a and 1b.

Human Health Risks

Human health risks were estimated for various exposure scenarios, based on current and reasonably anticipated future land uses, including current and future Native American (for example, elk hunting and harvesting vegetation by Shoshone Bannock Tribe), current and future seasonal rancher, current and future recreational hunter, and current and future recreational camper/hiker. Although future residential use is unlikely, a residential use scenario was used in the human health risk assessment to determine if land use controls restricting residential use may be warranted. The assessment determined that such land use controls are warranted. These scenarios evaluated the exposure to mining-related contaminants in environmental media (soil, sediment, surface water, and groundwater) at the Site. The routes of exposures evaluated included ingestion (eating), inhalation (breathing), dermal contact (touching), and direct radiation. More specifically, exposure routes evaluated were as follows:

- Current/future recreational hunters – direct soil contact (such as incidental soil ingestion, dermal contact with soil, and inhalation of fugitive dust) and consumption of wild game.
- Current/future recreational campers/hikers – direct soil contact.
- Current/future Native Americans – direct soil contact, direct surface water contact, and consumption of elk and vegetation.
- Current/future seasonal ranchers – direct soil contact, direct contact with groundwater used as a potable water supply (for example, ingestion and dermal contact with groundwater) and consumption of beef cattle that uptake contaminants while grazing at the Site.
- Hypothetical future residents – direct soil contact, direct contact with groundwater used as a potable water supply, consumption of homegrown fruits and vegetables.

In addition, radiological risk from exposure to uranium decay products was evaluated for each user.

What is a human health risk and how is risk determined?

A baseline human health risk assessment is an evaluation of the potential for adverse health effects caused by exposure to hazardous substances from a site if no remedial actions are taken. Generally, the following four-step process is used for assessing site-related human health risks:

Hazard Identification: Identify contaminants of potential concern (COPC) at the Site in various media, such as soil, groundwater, surface water, sediment, and air.

Exposure Assessment: Evaluate exposure pathways through which people might be exposed. This includes estimating the concentrations of COPCs in soil, groundwater, and other media and the frequency, duration, and intensity of exposure. Using these factors, the risk assessment calculates an average (or central tendency) and a reasonable maximum exposure (RME) scenario: the highest level of human exposure that could reasonably be expected.

Toxicity Assessment: The potential adverse health effects associated with contaminant exposures and the relationship between magnitude of exposure (dose) and severity of adverse effects (response) are summarized from standard EPA data sources. Adverse health effects include the risk of developing cancer over a lifetime or other diseases. Some contaminants cause both cancer and non-cancer health effects.

Risk Characterization: The final step combines the exposure and toxicity assessments to estimate site risks for all COPCs. Human health risks are calculated for cancer and non-cancer health effects. For humans, the likelihood of cancer resulting from exposure to site-related contaminants is expressed as a probability; for example, 1 in 10,000 or $1x10^{-4}$, which means that for every 10,000 people that are exposed to the contamination, one extra cancer may occur. "Extra" cancer means that one additional person may get cancer than would normally be expected. EPA has an acceptable risk range from 1 in 10,000 ($1x10^{-4}$) to 1 in 1,000,000 ($1x10^{-6}$) for developing cancer from site-related contaminants over a person's lifetime. DEQ applies a risk range of 1 in 100,000 ($1x10^{-5}$) to 1 in 1,000,000 ($1x10^{-6}$). For non-cancer health effects, a hazard index (HI) is calculated. Non-cancer health effects are not expected to occur if the hazard index is less than 1. If the HI is greater than 1, then it is possible that people could be poisoned. Typically, contaminants that exceed the cancer risk range or an HI of 1 require remedial action at a site and are referred to as contaminants of concern (COCs).

Non-Radiological Risk Estimates

Cumulative human health cancer risk and non-cancer hazard estimates for non-radionuclide contaminants are shown relative to the regulatory limits in Figures 5 and 6, respectively. Arsenic cancer risk estimates (Figure 5) were above EPA's acceptable risk range of 10^{-6} to 10^{-4} for the future resident, Native American, and seasonal rancher exposure scenarios. The risk from exposure to arsenic at the Ballard Mine was found to be largely attributable to naturally-occurring arsenic levels. For example, the upland soil and riparian soil exposure point concentrations used for the risk estimates were 21.8 and 5.8 mg/kg, while in background reference areas the upper estimates of the background data set for these media were 15.6 and 5.9 mg/kg, respectively. Non-cancer hazard index estimates (Figure 6) were above EPA's acceptable hazard index of 1 for the future resident, Native American, and seasonal rancher exposure scenarios. Multiple metals or metalloids were found to contribute to the elevated non-cancer hazard indexes including; arsenic, cadmium, cobalt, manganese, molybdenum, nickel, tin, selenium, thallium, and vanadium.

Radiological Risk Estimates

Radiological risk from exposure to uranium decay products was evaluated. The initial screening for the future resident, Native American, seasonal rancher, recreational hunter, and recreational camper/hiker indicated that risk levels were well above EPA's acceptable risk range and were estimated to be $2x10^{-1}$, $1x10^{-2}$, $5x10^{-4}$, $2x10^{-4}$ and $1x10^{-4}$, respectively. The primary radiological risk drivers were radium-226 and radon-222 (resident only). Considering the findings of the initial screening, risk estimates were refined using Site-specific data obtained during a supplemental radiological investigation. The supplemental radiological investigation concluded that risk levels from exposure to radiological compounds exceed EPA's acceptable risk range, however the calculated risk was only marginally different from background risk (for example, residential risk at the Site equaled $9x10^{-2}$, while versus residential risk at background areas was $7x10^{-2}$). The background risk levels are high due to naturally elevated levels of uranium in soil in background reference areas.

Figure 5. Human Health Reasonable Maximum Exposure (RME) and Central Tendency Exposure (CTE) Excess Lifetime Cancer Risk for all non-radionuclide contaminants.

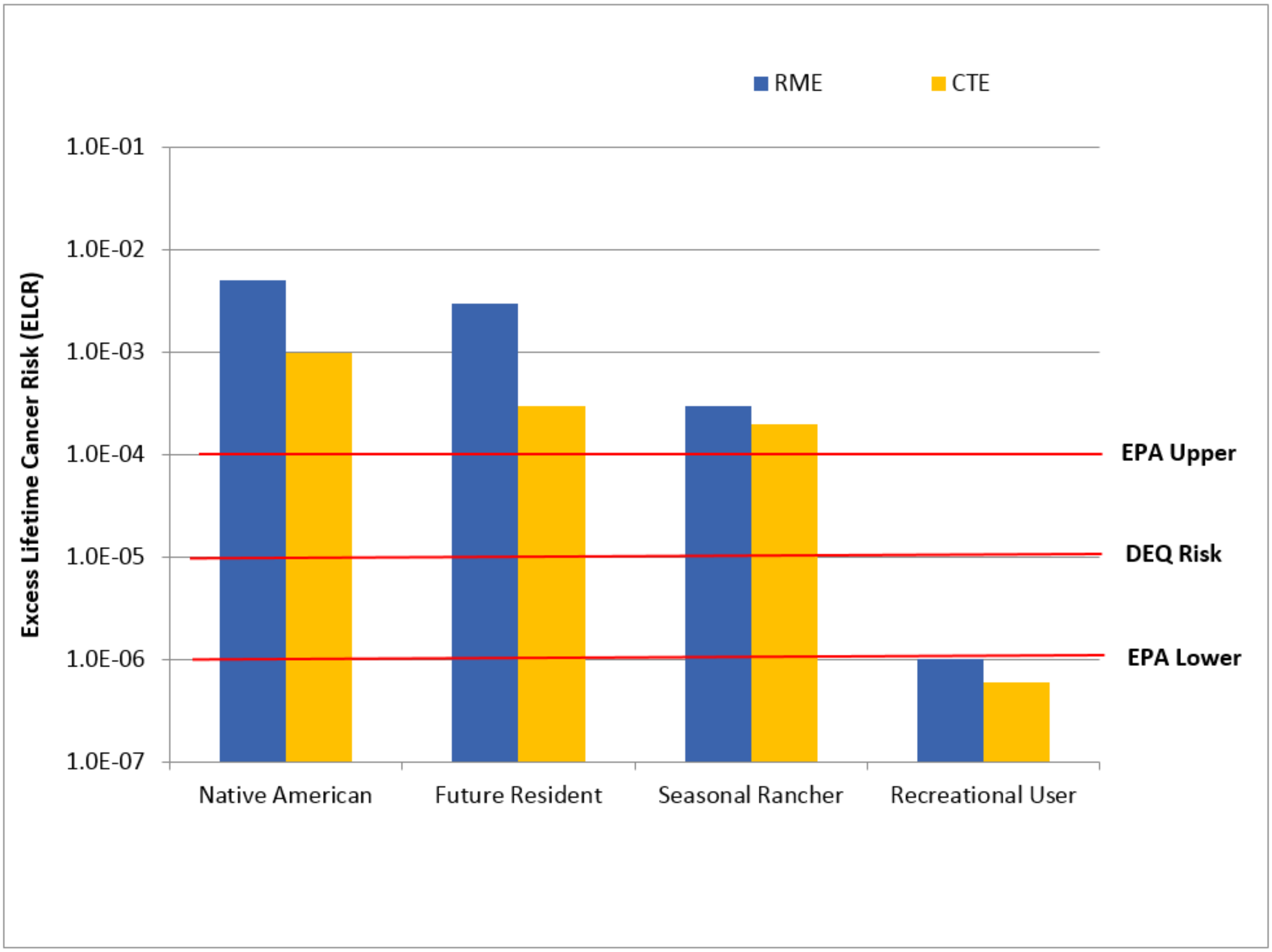
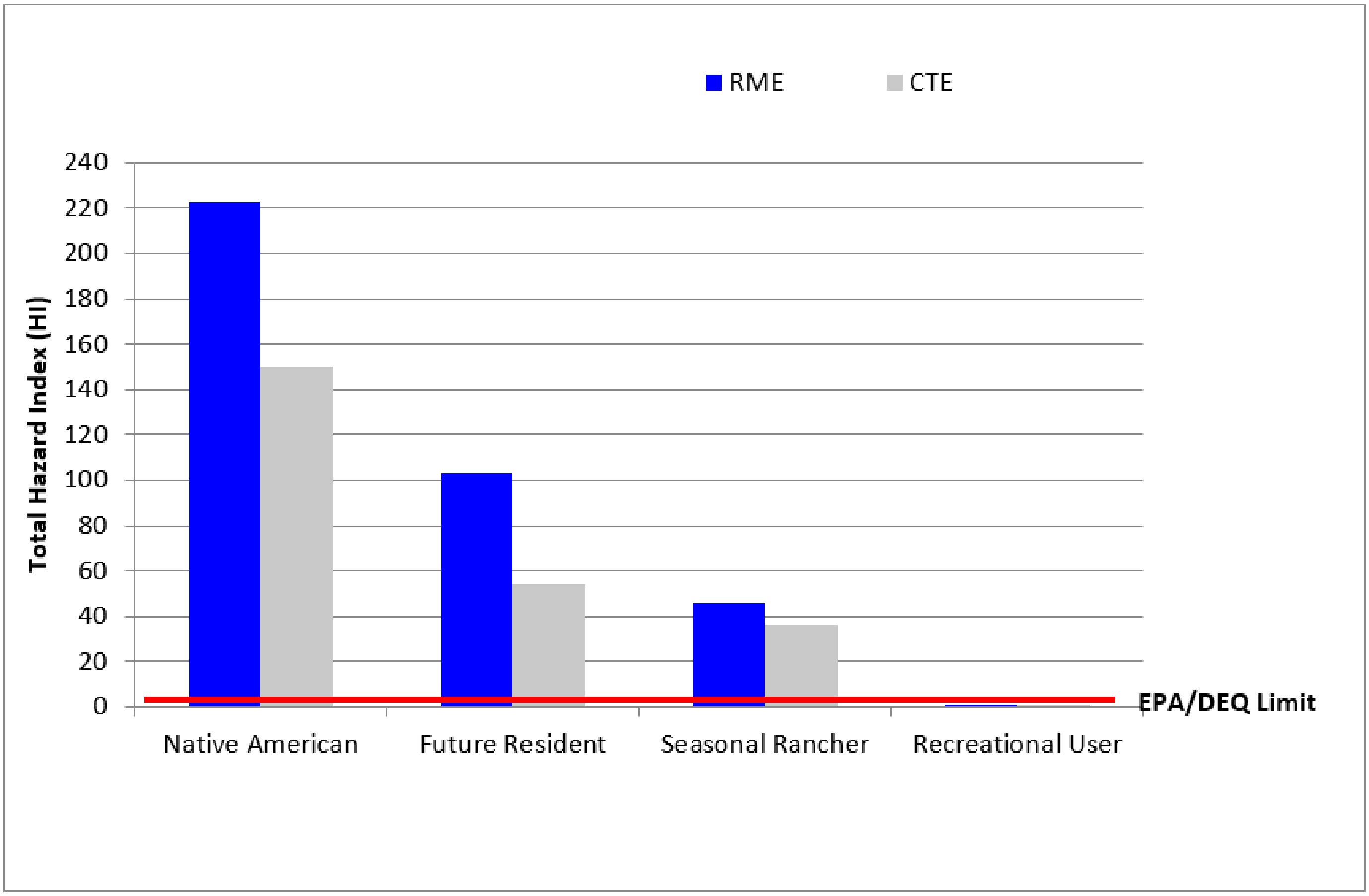


Figure 6. Human Health RME and CTE Cumulative (all media) Non-cancer Hazard Index for all non-radionuclide contaminants.



Summary of Human Health Risk Findings

- Cancer risk and non-cancer hazard estimates for non-radiological contaminants were below DEQ and EPA acceptable levels for the recreational hunter and camper/hiker exposure scenarios, indicating that these current and anticipated future land uses are not adversely affected at the Ballard Mine.
- Risk and hazard estimates for the Native American scenario were above the acceptable regulatory limits. Cancer risks are driven by arsenic in soil (incidental ingestion and uptake into vegetation) and sediment (uptake into vegetation) and uranium decay products in soil (direct radiation). Non-cancer hazards are driven by uptake into vegetation from arsenic, cadmium, cobalt, manganese, molybdenum, nickel, tin, selenium, thallium and vanadium in soil, sediment, or surface water.
- Risk and hazard estimates for future resident were above the acceptable regulatory limits. Risks are driven by arsenic in soil (incidental ingestion and uptake in to homegrown produce), uranium decay products in soil (direct radiation and inhalation in indoor air) and arsenic in groundwater used by a resident as drinking water and to water garden vegetables. Non-cancer hazards are driven by uptake into homegrown produce from arsenic, cadmium, molybdenum, tin, selenium, and thallium in soil or groundwater (used for drinking or watering a garden).
- Risk and hazard estimates for the seasonal rancher were above the acceptable regulatory limits. Risks are driven by arsenic in soil (incidental ingestion and uptake into beef consumed by the rancher), uranium decay products in soil (direct radiation) and ingestion of arsenic in groundwater. Non-cancer hazards are driven by consumption of beef that uptakes arsenic, cobalt, selenium, and thallium from soil, surface water, and groundwater, into beef.
- Arsenic (in soil and groundwater) and uranium decay products (in soil; radium-226 and radon-222) were identified as the contaminants that pose the greatest risk to humans. The majority of the arsenic and uranium risk were attributable to background levels rather than Site-related activities.

Ecological Risks

Ecological risk estimates were calculated for the most plausible ecological exposure pathways based on contaminant release and transport, available habitat, biota types present, and available food sources.

The exposure pathways for general groups of ecological receptors (including terrestrial, riparian, and aquatic) evaluated in the baseline ecological risk assessment are identified next:

Terrestrial (Upland) Wildlife

- Incidental ingestion of contaminants in source materials, soil, and surface water through feeding, foraging, or grooming
- Plant uptake of contaminants in source materials and soil
- Dietary uptake of contaminants in prey (food web transfer)

Terrestrial (Riparian) Wildlife

- Incidental ingestion of contaminants in soil, sediment, and surface water through feeding, foraging, or grooming
- Plant uptake of contaminants in soil, sediment, and surface water
- Dietary uptake of contaminants in prey (food web transfer)

Aquatic and Benthic Receptors

- Direct contact with surface water and sediment
- Dietary uptake (food web transfer)

American goldfinch, American robin, coyote, deer mouse, elk, great blue heron, long-tailed vole, mallard, mink, raccoon and northern harrier were selected as representative wildlife receptors for the ecological risk assessment. In addition, aquatic organisms as a group were evaluated.

Risk to Aquatic Organisms

The streams at or near the Site do not support fisheries because of their intermittent or ephemeral nature, however these tributaries do flow seasonally into Wooley Valley Creek and the Blackfoot River. HQs for aquatic organisms (for example, amphibians) exposed to contaminants in surface water at the Ballard Mine are in excess of DEQ's and EPA's acceptable hazard criterion of 1 for dissolved barium (HQ=10), boron (HQ=19), dissolved cadmium (HQ=2), dissolved manganese (HQ=3), total selenium (HQ=101), and dissolved uranium (HQ=4).

Risk to Terrestrial and Riparian Wildlife

Effect-based ecological HQs were calculated for terrestrial and riparian upper trophic level wildlife exposed to contaminants in combined media (soil, sediment, and surface water) at the Ballard Mine.

Key findings identified during the ecological risk assessment are as follows:

- HQ estimates in excess of 1 were calculated for the following receptors at the Ballard Mine: long-tailed vole, American goldfinch, deer mouse, raccoon, American robin, mallard, mink, great blue heron, and northern harrier.
- Contaminants with HQ estimates in excess of 1 are: antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc.
- The greatest risk to wildlife was identified from exposure to selenium (see Figure 7 on page 15).

What is an ecological risk and how is this determined?

A **baseline ecological risk assessment** uses site-specific information to evaluate the potential for adverse effects to biota caused by exposure to hazardous substances from a site if no remedial actions are taken. Generally, the following process is used to assess site-related ecological risks:

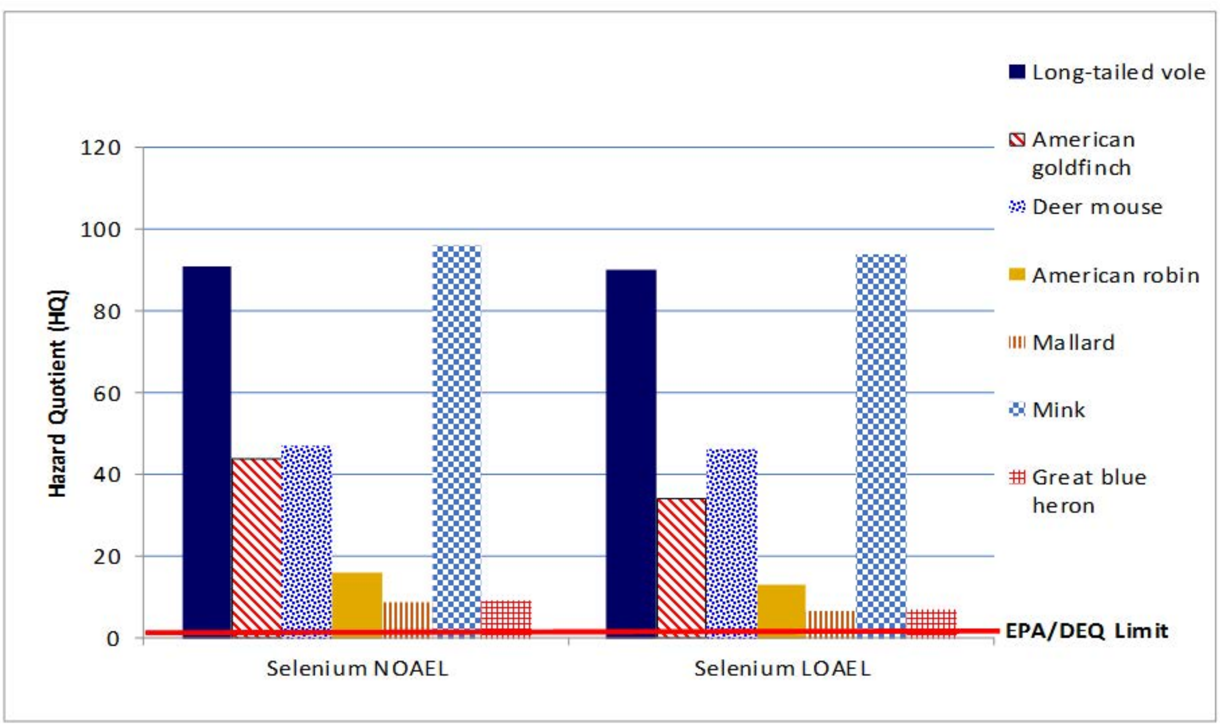
Problem Formulation: Types and quality of ecological habitat and biota (including any state or federal threatened or endangered species) using the area are identified. Identify contaminants of potential ecological concern (COPEC) at the Site in various media, such as soil, groundwater, surface water, sediment, and air.

Exposure Assessment: Identify the different exposure pathways through which biota might be exposed to COPECs. Contaminant concentrations measured in site media or biota tissue, biota-specific exposure assumptions, and chemical-specific bioaccumulation models are used to quantify wildlife exposure levels.

Ecological Effects Assessment: Information obtained from literature reviews, field studies, or toxicity tests are used to describe the relationship between contaminant concentrations and their effects on ecological receptors. No observable adverse effects levels (NOAEL) and lowest observable adverse effects levels (LOAEL) are both identified. Although other evidence is considered, NOAELs and LOAELs are generally used to assess the risk to individuals and populations, respectively.

Risk Characterization: The final step combines the exposure and ecological effects assessments to provide a quantitative assessment of the risk posed to ecological receptors. Individual risk estimates for a given receptor and contaminant are calculated as a hazard quotient (HQ), which is the ratio of contaminant concentration to a toxicological benchmark believed to be protective. In general, an HQ above 1 indicates a potential for unacceptable risk and remedial action may be required. The estimated risk (magnitude of the HQs) for ecological receptors is described along with the degree of confidence in the risk estimates where the supporting evidence and uncertainties surrounding the exposure and effects evaluations is also considered to identify the potential for unacceptable ecological impacts.

Figure 7. Selenium Hazard Quotients for Wildlife



Livestock Risk Assessment

EPA's CERCLA risk assessment guidance is specifically related to evaluations of potential health impacts to people and wildlife, it does not pertain to livestock or other domesticated species. There are several documented cases of livestock mortalities occurring at, or near, phosphate mines in southeast Idaho. These include cattle deaths at the Ballard Mine and sheep deaths at the Henry Mine. These deaths are believed to have occurred during acute short-term exposures to high concentrations of selenium in milk-vetch or asters known to grow on waste rock material. These plants are referred to as hyperaccumulators. Considering this, potential risks to livestock were evaluated for the Ballard Mine to inform land use decisions and protect livestock. Acute and chronic exposures were both evaluated. The livestock risk evaluation found that selenium (HQ=2.5) was the only contaminant resulting in chronic effects-based HQ in excess of 1 for livestock at the Ballard Mine.

Basis for Action

It is EPA's judgment that the Preferred Alternative identified in this Proposed Plan, or one of the other active measures considered in the Proposed Plan, is necessary to protect public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

Remedial Action Objectives and Goals

Remedial Action Objectives (RAOs):

For waste rock and upland soils, the RAOs are:

1. For Human Health – prevent or inhibit direct contact (incidental ingestion) of waste rock and upland soils contaminated with arsenic or uranium (Radionuclides of Concern [ROC]): Radium-226, Radon-222) by seasonal ranchers or tribal users; and prevent or reduce migration of contaminants to groundwater and surface water.
2. For the Environment – prevent or reduce unacceptable risk to birds and mammals from incidental ingestion of waste rock and upland soil particles and ingestion of prey contaminated with COCs (antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc); and prevent or reduce migration of contaminants to groundwater and surface water.

For stream sediments and riparian overbank deposits, the RAOs are:

1. For Human Health – prevent direct contact (dermal contact or incidental ingestion) of stream sediment and riparian overbank material containing arsenic or ROCs by seasonal ranchers or tribal users.
2. For the Environment – prevent or reduce unacceptable risk to amphibians and macroinvertebrates and birds and mammals by incidental ingestion of sediments and riparian overbank deposits and ingestion of prey contaminated with antimony, cadmium, chromium, copper, molybdenum, nickel, selenium, thallium, vanadium, and zinc.

For vegetation, the RAOs are:

1. For Human Health – prevent or reduce ingestion of vegetation contaminated with arsenic, selenium, or uranium by tribal users or seasonal ranchers.
2. For the environment – Prevent or reduce ingestion of vegetation contaminated with selenium by aquatic (amphibians and macroinvertebrates) and terrestrial receptors (mammals).

For surface waters, the RAOs are:

1. For Human Health – prevent or reduce direct contact (dermal contact or incidental ingestion) of surface water, and the uptake of surface water containing arsenic, cadmium, and selenium into food (e.g., livestock and vegetation) that is consumed by seasonal ranchers or tribal users; and comply with applicable and relevant or appropriate requirements (ARARs).
2. For the Environment – prevent or reduce unacceptable risk to amphibians and macroinvertebrates from direct contact with surface water contaminated with cadmium and selenium; and comply with ARARs.

For groundwater, the RAOs are:

1. For Human Health – prevent ingestion of groundwater containing arsenic, cadmium, or selenium by seasonal ranchers; comply with ARARs; and return useable groundwater to beneficial uses within a reasonable time frame.

Preliminary Remediation Goals

The preliminary remediation goals (PRG), represent the concentration thresholds for contaminants and media that are protective of human health and the environment. In developing PRGs, EPA considers ARARs, acceptable exposure levels (or risk-based concentration levels [RBCL]), and other factors such as background levels of contaminants in various media, and other pertinent information. Final remediation goals (or cleanup levels) will be established in the ROD.

For human health, EPA considers acceptable exposure levels to be concentration levels of carcinogens that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} (1 in 10,000 probability) to 10^{-6} (1 in 1,000,000 probability) or less; and concentration levels of non-carcinogens that are below toxicity reference doses protective of human health (a hazard index of 1).

For ecological receptors, EPA considers acceptable exposure levels to be concentration levels that are below toxicity reference values or benchmarks protective of ecological populations.

Exposure and toxicity information used in the final *Remedial Investigation Report and Risk Assessment for P4's Ballard Mine* (MWH, 2014) and its *Baseline Risk Assessment Addendum* (MWH, 2015) provided the basis for calculating numeric RBCLs protective of human health and the environment.

PRGs for surface water and groundwater are presented in Table 2. These are based primarily on ARARs.

PRGs for COCs in solid media are presented in Table 3. The PRG for each COC in soil or sediment is equal to the most conservative RBCL developed for a human that may be exposed under the current and reasonably anticipated land uses (agriculture, seasonal ranching, recreation, and tribal use) and ecological receptors, unless the background concentration is greater, in which case the background level is the PRG. In most cases, PRGs are based on background levels.

Table 2. Surface Water and Groundwater PRGs

Medium COC	Current Background Concentration[a] (µg/L)	Preliminary Remediation Goals	Basis
Surface Water			
Arsenic	1.09	6.2	See note [b], below
Cadmium	0.10	0.6	IDAPA 58.01.02[c]
Selenium	0.772	3.1	FWQC[d] (EPA, 2016)
Groundwater[e]			
Arsenic	1.03	10	MCL
Cadmium	0.401	5	MCL
Selenium	2.78	50	MCL

Notes:

All concentrations are ug/L.

[a] Background concentration is equal to the upper threshold value (95% USL) of the background data set.

[b] Letter to Barry Burnell, Idaho DEQ from Daniel Opalski, EPA Region 10, dated September 15, 2016, Re: EPA Disapproval of Idaho's Arsenic Human Health Water Quality Criteria, and Letter to Barry Burnell, Idaho DEQ from Daniel Opalski, EPA Region 10, dated September 27,2016, Re: Arsenic Human Health Water Quality Standards for Surface Waters in Idaho.

[c] State of Idaho Surface Water Quality for Aquatic Life (IDAPA 58.01.02); Criterion Continuous Concentration for Water and Organisms. Note that criterion is hardness dependent and that progress toward attaining PRG to consider site-specific hardness.

[d] Federal Water Quality Criterion. Aquatic Life Ambient Water Quality Criterion for Selenium – Freshwater 2016 (EPA 822-R-16-006, June 2016). Note that the criterion includes elements for concentration in both fish tissue and water. If fish-tissue data become available at any monitoring stations, it will be compared with fish-tissue element(s) of the criterion to evaluate progress toward attaining PRG. Fish-tissue elements, in order of hierarchy are: (1) Egg-Ovary = 15.1 mg/kg dry weight; (2) Whole Body = 8.5 mg/kg dry weight; and (3) Muscle = 11.3 mg/kg dry weight.

[e] EPA National Primary Drinking Water Regulations

MCL = maximum contaminant level

PRGs for vegetation are not included; rather, performance targets for vegetation will be used to monitor the effectiveness of the remedy of the cover over upland soils and waste rock. The performance targets will be based on published research about plant bioaccumulation of selenium and trace metals in natural settings.

Table 3. Soil and Sediment PRGs

Primary Media COC	Background Value[a] (mg/kg)	Preliminary Remediation Goals[be] (mg/kg)
Upland Soil		
Antimony	3.60	3.60
Arsenic	15.6	15.6
Cadmium	41.0	41.0
Chromium	410	410
Copper[f]	51.9	74.5
Molybdenum	29.0	29.0
Nickel	220	220
Radium-226[c]	15.1	15.1
Radon-222	[d]	[d]
Selenium	29.0	29.0
Thallium	1.10	1.10
Uranium	36.0	36.0
Vanadium	300	300
Zinc	1,200	1,200
Riparian Soil		
Arsenic	5.93	5.93
Cadmium[f]	5.02	7.24
Chromium	43.3	43.3
Copper	24.3	24.3
Molybdenum	0.653	0.653
Nickel	29.6	29.6
Selenium	2.03	2.03
Thallium	0.483	0.483
Vanadium	57.9	57.9
Sediment		
Antimony	5.00	5.00
Arsenic	4.55	4.55
Cadmium	4.17	4.17
Copper	25.5	25.5
Molybdenum[f]	< 0.5	0.541
Selenium	1.48	1.48
Thallium	0.378	0.378
Vanadium[f]	49.1	113

Notes:

[a] The 95-95 upper threshold limit was selected as the proposed background level for upland soils collected in 2009 and 2014. The 95-percent USL was selected as the proposed background level for sediment and riparian soil datasets collected in 2004 and 2010.

[b] The PCL is equal to the greater of the background concentration or the most conservative human health and ecological RBCL.

[c] Radium-226 are in pCi/g.

[d] Radon is an inhalation risk, typically associated with residential indoor air scenario which is not a foreseeable future use.

[e] All PRGs are based on background levels unless otherwise noted

[f] Risk level for Copper (based on HQ=1 for birds (American Robin); Cadmium (based on a HQ=1 for protection of Native Americans consuming culturally significant vegetation in riparian areas); Molybdenum (based on HQ=1 for mammals (mink); Vanadium (based on a HQ=1 for birds (Great Blue Heron)

< = less than

mg/kg = milligram per kilogram

Summary of Remedial Alternatives

Remedial Alternative Evaluation

This section summarizes and presents the remedial alternatives evaluated in detail in the FS. It is organized by media. Cleanup methods and technologies were evaluated for each of the following media: upland soils and waste rock, stream channel sediment and riparian soil, surface water, and groundwater.

A list of all the alternatives considered for each medium, and those that were retained for detailed evaluation are shown in Table 4. For each medium-specific alternative, basic information about the components, distinguishing features, expected outcomes, cost and other information is summarized. For each medium, a preferred alternative is identified.

With the exception of Alternative 1 (the No Action Alternative), all other alternatives are expected to be protective of human health and the environment and to comply with ARARs.

A comprehensive, sitewide Preferred Alternative that addresses all media is presented later in this Proposed Plan. This sitewide Preferred Alternative is the combination of the media-specific Preferred Alternatives.

Elements Common to All Action Alternatives

All alternatives, except the no-action alternative, include institutional controls (ICs), O&M requirements, long-term monitoring (LTM), and adaptive management planning. All of these elements supplement the engineering controls and treatment technologies included in the media-specific alternatives.

Institutional Controls

ICs are administrative and/or legal mechanisms intended to control land use to minimize the potential for people to be exposed to contamination by limiting land or resource use, and to maintain the integrity of the engineered components of the remedy. Examples of ICs include easements and covenants to restrict land use, restricting water use, prohibitions on drilling wells for domestic use, and the like.

Additional and more specific ICs will be developed during remedial design. Other land use controls such as fences, signs, grazing plans, and the like are also included in the alternatives.

Operation and Maintenance

O&M is an integral component of all alternatives, and ensures the proper functioning and integrity of engineering controls such as the cover system and the proper functioning of treatment facilities, sediment control best management practices (BMP), and others. Each media-specific alternative includes a variety of O&M requirements. The specific O&M requirements vary depending on the cleanup method or technology and will be refined during remedial design

Long-term Monitoring

Monitoring is also an integral component of all alternatives to assess the effectiveness of the remedy. The monitoring program will include periodic inspections of engineered facilities; and sampling and analysis of groundwater, surface, sediment, riparian soil, vegetation, and upland soil.

Adaptive Management Planning

Adaptive management is a structured, iterative process for making decisions on complex projects where there is uncertainty about the effectiveness of cleanup methods or technologies. Adaptive management for the Ballard Site will create a structured process for measuring and/or monitoring elements of the remedy, and determine if additional designs, design modifications, or operational changes are necessary to achieve RAOs. An adaptive management plan (AMP) will be developed for the selected combined remedy during remedial design. None of these modifications are anticipated to constitute a significant or fundamental change to the remedy selected in the ROD.

No Action Alternative

Alternative 1: No Action

Estimated Cost/Time	
Capital Costs	$0
Total O&M Costs (30 years)	$0
Total Periodic Costs (30 years)	$107,885
Total Present Value Costs	$108,000
Construction Time Frame	None
Time to Achieve RAOs	Will never comply with RAOs

Superfund regulations require a No Action Alternative be evaluated to establish a baseline for comparison with other alternatives. Thus, No Action is presented with each medium as Alternative 1. For the purposes of this summary, we only include it once. Under the No Action Alternative, mine materials would be left in their current condition and no additional cleanup action would be performed. Five-year site reviews would be performed, as required by law where the remedy leaves contamination in place, to evaluate whether the remedy remains protective (see Total Periodic Costs [30 years]). Monitoring would only be performed as necessary to support 5-year site reviews.

This alternative is not protective of human health and the environment and does not comply with ARARs.

Table 4. Alternatives Considered During Initial Screening and During Detailed Evaluation

No.	Remedial Alternative	Cover notes	Preferred Alt.	ICs	LUCs	O&M	LTM	Retained for Detailed Evaluation? [Yes/No]
Upland Soil/Waste Rock Alternatives (USWR)								
1	No Action	No cover						Y
2	Grading, Stormwater Controls	No cover			Y	Y	Y	N
3	Grading and Consolidation w/Soil Cover	12 to 18 inches alluvial soil		Y	Y	Y	Y	N
4	Grading and Consolidation w/ET Cover	5 feet alluvial soil, 1 foot capillary break		Y	Y	Y	Y	Y
5	Gradings and Consolidation w/Multi-layered Cover System	3 feet alluvial soil, drainage geotextile, GCLL, 6 to 12 inches cushion layer		Y	Y	Y	Y	N
6	Grading and Consolidation, Incidental Ore Recovery, ET Cover	5 feet alluvial soil, 1 foot capillary break	Y	Y	Y	Y	Y	Y
7	Consolidation of Upland Soil/Waste Rock into Pits, ET Cover	5 feet alluvial soil, 1 foot capillary break		Y	Y	Y	Y	Y
Surface Water Alternatives[a] (SW)								
1	No Action							Y
2	Sediment traps			Y	Y	Y		Y
3	In Situ Biological Treatment (Wetlands) of Seeps		Y	Y	Y	Y	Y	Y
4	Ex Situ Bioreactor Treatment of Seeps			Y	Y	Y	Y	N
5	Ex Situ Treatment of Seeps			Y	Y	Y	Y	N
Sediment/Riparian Soil[a] (S/R Soil)								
1	No Action							Y
2	Monitored Natural Recovery (MNR)			Y	Y		Y	N
3	Sediment Traps/Basins and MNR		Y	Y	Y	Y	Y	Y
4	Removal w/Onsite Disposal and MNR			Y	Y		Y	Y
Groundwater[a] (GW)								
1	No Action							Y
2	Monitored Natural Attenuation (MNA)			Y			Y	Y
3	Limited PRB Treatment (Alluvial Groundwater) and MNA		Y	Y		Y	Y	Y
4	In Situ Treatment (Alluvial Groundwater) and MNA (Wells Groundwater)			Y		Y	Y	N
5a	Extraction and Treatment (Wells Groundwater) and MNA (Alluvial Groundwater)			Y		Y	Y	N
5b	Extraction and Treatment of Alluvial and Wells Formation Groundwater			Y		Y	Y	Y

Notes:
GCLL = geosynthetic clay laminate liner
[a] Except for the No Action alternatives, all surface water, sediment/riparian soil, and groundwater alternatives rely on upland soil/waste rock source control measures to mitigate future generation of contaminated surface water, sediment, and groundwater, respectively.

Upland Soil/Waste Rock (USWR) Media Alternatives

Three action alternatives for upland soil and waste rock were evaluated in detail in the FS. Each of these alternatives share some common elements. All would grade and shape waste rock dumps to promote runoff, but with varying degrees of pit backfill and earthworks. All of the alternatives would include construction of a 500-acre cover system over the mine wastes that are left at the Site. One alternative (USWR 6) assumes that ore will be recovered during implementation of the remedy, and two others (USWR 4 and 7) assume no ore recovery during the remedial action. The alternative that accommodates ore recovery was developed at the request of P4, and would be contingent on the BLM issuing a phosphate mineral lease and approving a mine plan for ore recovery. All of the retained USWR Alternatives will achieve human health and environmental RAOs for this media in a reasonable time frame through construction of an ET cover. All USWR remedial alternatives will comply with federal and state mine reclamation requirements. The cover systems will also meet requirements under the Uranium Mill Tailing Radiation Control Act (UMTRCA) that engineering controls be designed to be effective for at least 200 years.

The preferred USWR alternative is USWR 6.

Upland Soil/Waste Rock Alternative 4 (USWR 4)—Grading and Consolidation with an Evapotranspiration Cover System, Institutional Controls, and Operations and Maintenance/Long-term Monitoring

Estimated Cost/Time	
Capital Costs	$50,099,136
Institutional Control Costs	$25,000
Total O&M Costs (30 years)	$388,294
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$50,679,000
Construction Time Frame	3 to 5 years
Time to Achieve RAOs	3 to 5 years

USWR 4—Grading and Consolidation with an Evapotranspiration Cover System, Institutional Controls, and Operations and Maintenance/Long-term Monitoring

Under USWR 4, portions of the upland soil/waste rock dumps throughout the Site would be excavated and consolidated in the onsite pits to cover any exposed beds of the Phosphoria Formation, or graded/contoured in-place to create slopes that effectively shed stormwater and snowmelt (maximum of 3:1 slopes). The new upland soil/waste rock surfaces inside and outside of the pits would be capped with an ET cover system (3.7 million cubic yards). The ET cover soils would come from designated borrow sources onsite and adjacent to the site and would be designed to effectively shed or store infiltrating water. Stored water would evaporate or be transpired by the vegetation planted on the surface of the cover system before the water can infiltrate into the underlying waste rock. Based on current information regarding nearby borrow material and a preliminary cover analysis (modeling), the selected ET cover would consist of (starting from the top of the cover) the following:

- 5-foot thickness of medium-grained, unimpacted alluvial material
- At least 1-foot thickness of high-permeability (coarse grained), unimpacted fill material to act as a capillary break

An ET cover would also extend over areas where the original waste rock was excavated for placement into the pits, thereby exposing the underlying native surface soils (assumed to have elevated residual contaminant concentrations).

Reclamation vegetation types would be selected to form an extensive root system to effectively mitigate stormwater and snowmelt sheet flow and rill erosion of the cover surface and to transpire water that infiltrates the upper layer of the cover system. LTM/O&M would be necessary to inspect the cover for plants that are incompatible with the selected cover system (vegetation with roots that could penetrate the ET cover system) and to repair any stormwater erosion that might occur to the cover system. ICs and fencing would be implemented to preserve the integrity of the waste rock cover by preventing activities that could compromise the cover.

USWR 4 effectively reduces infiltration of water through the waste rock, which prevents or reduces migration of contaminants and, therefore, is protective of human health and the environment. This cover is made of earthen materials that are available onsite or adjacent to the Site.

USWR 6—Grading and Consolidation, Incidental Ore Recovery, Evapotranspiration Cover System, Institutional Controls, and Operations and Maintenance/Long-term Monitoring

Estimated Cost/Time	
Capital Costs	$36,974,250
Institutional Control Costs	$50,000
Total O&M Costs (30 years)	$388,294
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs[a]	$36,974,250
Construction Time Frame	6 to 8 years
Time to Achieve RAOs	6 to 8 years

[a] No mining costs included. See Feasibility Study Technical Memorandum No. 2, April 2017, MWH, for additional details.

USWR 6 is similar to USWR 4, except that some ore would be recovered during remedy implementation. The ore reserve was identified during the RI/FS, and a review of historical data and recent exploration data confirmed the availability of approximately 4 million tons of high-carbon ore suitable for removal at the Ballard Mine Site. Capital costs are $36.9 million and do not include total capital costs for ore extraction.

It is important to note that ore recovery would require separate decisions by the BLM to issue a phosphate mineral lease and approve a mine plan for ore recovery. The CERCLA process would not authorize ore recovery activities. In addition, the CERCLA 121(e) permit exemption does not apply to BLM mineral leasing and mine permitting requirements. EPA would work closely with P4 and BLM to coordinate the cleanup with ore recovery.

USWR 6 effectively reduces infiltration of water through the waste rock, which prevents or reduces migration of contaminants and, therefore, is protective of human health and the environment. This alternative also has the following features that distinguish it from USWR 4 and 7:

- Recovery of ore would produce additional overburden and waste rock suitable for use as backfill. The ET cover will incorporate a layer of capillary break material salvaged from the mining activities and require approximately 4.3 million cubic yards of material from local borrow areas. Mine pits would be backfilled to a greater extent than USWR 4, resulting in constructed landforms that appear more natural and blend into the adjacent native upland surfaces. These landforms may more effectively shed water from the cover system and Site.
- The estimated cost of the remedial aspects of this alternative is $36.9 million. A significant portion of the total capital cost of all earthworks is attributed to ore recovery, which reduces the scope and cost of earthworks associated with implementation of the CERCLA remedial action.
- Similar to USWR 4 and 7, Alternative 6 would include ICs and fencing to restrict activities that could disturb the final cover system and the underlying wastes, and O&M/LTM to confirm the integrity of the cover system and to prevent the growth of incompatible plants from the selected cover system.

USWR 7—Complete Consolidation of Existing Upland Soil/Waste Rock into the Pits, Evapotranspiration Cover System, Institutional Controls, and Operations and Maintenance/Long-term Monitoring

Estimated Cost/Time	
Capital Costs	$112,540,985
Institutional Control Costs	$25,000
Total O&M Costs (30 years)	$388,294
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$113,121,000
Construction Time Frame	5 to 7 years
Time to Achieve RAOs	5 to 7 years

USWR 7 will excavate and consolidate all upland soil/waste rock in the existing pits and to cover any exposed Meade Peak Member of the Phosphoria Formation (ore beds). The new surface would then be graded/contoured to create slopes that effectively shed stormwater and snowmelt.

The volume of existing waste rock is sufficient to contour the sides of the existing pits crest to crest, to cover the exposed ore beds, and to create 3:1

maximum slopes and a topography surface that directs stormwater out of the pits and away from the source area. The graded upland soil/waste rock surfaces would be capped with the ET cover, as described in USWR 4. As with Alternatives 4 and 6, this alternative includes ICs to restrict activities that could disturb the cover systems and O&M/LTM to maintain the integrity of the cover system and to limit growth of plants that are incompatible with the selected cover system.

Surface Water (SW) Alternatives

Once the ET cover for upland soil/waste rock is constructed, the majority of the surface water at the Site would have no contact with Site contaminants. Seeps and springs at the margins of the Site are expected to dry up or significantly decrease in flow over time; however, residual amounts of surface water from some of the mine-affected seeps/springs would remain for an indefinite period of time. Two alternatives were evaluated to address impacts to surface water associated with residual seeps and springs. RAOs are expected to be achieved for human health and the environment by both alternatives because of the anticipated effectiveness over time of the ET cover, ICs and other remedial actions (monitored natural recovery, sediment basins, and wetlands) associated with each alternative. For surface water, the remedial alternatives under consideration all rely on the robust source control strategies. These engineering controls isolate waste rock from water, effectively reducing the concentration of contaminants in stormwater runoff that discharges to local streams. Remedial features, described in the surface water alternatives, will capture and remove contaminants during and following implementation of remedial action. These activities, in some combination, will attain ARARs in affected waterbodies. The preferred alternative is SW 3.

SW 2—Institutional Controls

Estimated Cost/Time	
Capital Costs	$86,112
Institutional Control Costs	$50,000
Total O&M Costs (30 years)	$497,924
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$850,000
Construction Time Frame	5 to 10 years (constructed with cover)
Time to Achieve RAOs	5 to 10 years (after construction)

ICs and fencing would be implemented to restrict surface water access and use until source controls have substantially reduced mine-affected seep/spring discharge or cleanup levels are achieved. In addition to the remedial cover system selected for the upland soil/waste rock, sediment traps/basins would be installed in drainage areas during remedial construction to control ongoing and uncontrolled contaminated sediment releases caused by stormwater.

SW 3—In Situ Biological (Wetlands) Treatment of Source Area Seepage

Estimated Cost/Time	
Capital Costs	$576,835
Institutional Control Costs	$50,000
Total O&M Costs (30 years)	$589,254
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$1,432,000
Construction Time Frame	5 to 10 years (concurrent with cover construction)
Time to Achieve RAOs	5 to 10 years (after construction)

In concert with the construction of the ET cover for the upland soils and waste rock, SW 3, in situ biological treatment cells (or wetlands), would be constructed at mine-affected perennial seep/spring locations in addition to ICs and fencing. The residual mine-affected water at the seeps/springs would be treated via biologically mediated reactions, including reduction using anaerobic bacteria, resulting in the removal of contaminants through precipitation or sorption.
The treated water would flow out of the treatment cells to the downstream drainages or evapotranspire within the treatment cells.

Stream Channel Sediment and Riparian Soil (S/RS) Alternatives

Two action alternatives were evaluated to address sediment and riparian soil in the ephemeral and intermittent drainages near the Site. A general description of each alternative for stream channel sediment/riparian soil is presented in the following paragraphs. Each S/RS alternative assumes that an ET cover associated with one of the USWR alternatives will be implemented over upland soils and waste rock. RAOs are expected to be achieved for human health and the environment by both alternatives because of the benefits of the ET cover, ICs, and remedial actions associated with each alternative. S/RS 4 advocates physical removal of all contaminated material and reconstruction which would be more intrusive to the riparian areas. The preferred alternative is S/RS 3. Although S/RS 4 will be more effective because of removal of contaminated channel and bank materials, it would also be more damaging to sensitive riparian areas along drainage areas. For stream channel sediment and riparian soils, ARARs will more readily be achieved by S/RS 3, which relies on monitored natural recovery to reclaim impacted reaches. This alternative also complies with Section 404 of the Clean Water Act (CWA) which requires any mitigation sequence to avoid, and minimize disturbances to riparian areas (wetlands) unless unavoidable.

S/RS 3—Sediment Traps/Basins, Monitored Natural Recovery, and Institutional Controls

Estimated Cost/Time	
Capital Costs	$240,433
Institutional Control Costs	$75,000
Total O&M Costs (30 years)	$204,216
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$736,000
Construction Time Frame	5 to 10 years (concurrent with cover construction)
Time to Achieve RAOs	10+ years after construction

Under S/RS 3, sediment traps/basins would be installed in the upper reaches of the mine-affected drainages. The basins, installed at the lowest elevation of the upper reaches, would capture contaminated sediment entrained in the stormwater runoff during construction of the remedial cover. Sediment in these traps would be cleaned out periodically and disposed of in a designated area under the upland soil/waste rock cover system. MNR, which relies on natural erosion and sediment transport processes (physical, chemical, biological) to reduce contaminant concentrations in the affected media over time, is proposed for downstream reaches beyond the area disturbed by mining, where contaminant concentrations are lower. Implementation of MNR during the remedial action (RA) would require routine sediment/riparian sampling at known locations down to the confluence with the Blackfoot River over a designated time frame, and periodic data evaluations to track the progress of natural recovery and to support CERCLA 5-year reviews. ICs and fencing would also be implemented to limit human access to all mine-affected reaches of the drainages until cleanup levels are achieved.

S/RS 4—Removal and Onsite Disposal, Monitored Natural Recovery, and Institutional Controls

Estimated Cost/Time	
Capital Costs	$1,219,988
Institutional Control Costs	$75,000
Total O&M Costs (30 years)	$80,126
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$1,591,000
Construction Time Frame	5 to 10 years (concurrent with cover construction)
Time to Achieve RAOs	10 years after construction

Sediment/riparian soil (and all associated vegetation) in the upper reaches of the mine-affected drainages, where the highest contaminant concentrations are detected, would be excavated, transported, and consolidated under the ET cover system, and impacted drainages would then be reconstructed and revegetated. MNR, ICs, and fencing would be implemented, as described in S/RS 2, for sediment/riparian soil not removed in the distal reaches of the mine-affected drainages where contaminant concentrations are lower.

Groundwater (GW) Alternatives

Three alternatives were evaluated in detail in the FS. The alternatives ranged from a passive approach utilizing MNA to a semi-passive approach using PRBs to an active remedial approach involving pumping and treatment of groundwater. All three depend upon the successful implementation of the cover system (USWR Alternatives) to prevent precipitation and snow melt from contributing to groundwater contamination. Elements common to all three alternatives include the implementation of ICs to prevent access to the groundwater. RAOs are expected to be achieved for human health and the environment by each alternative because of these elements and associated remedial actions. To meet RAOs at the Site, a combined remedy must significantly reduce the release of contaminants from source areas to groundwater. Remedial features, described in the groundwater alternatives, will further capture and remove contaminants during and following implementation of remedial action. The concentration of contaminants are expected to decline through source control and subsequent dilution, dispersion, and natural attenuation. The combination of remedial measures described in the alternatives will achieve MCLs in a reasonable time frame. The preferred alternative is GW 3.

GW 2—Monitored Natural Attenuation and Institutional Controls

Estimated Cost/Time	
Capital Costs	$166,222
Institutional Control Costs	$125,000
Total O&M Costs (30 years)	$881,076
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$1,389,000
Construction Time Frame	5 to 10 years (constructed concurrent with cover)
Time to Achieve RAOs	10+ years after cover construction

This alternative includes MNA, which relies on natural physical, chemical, and biological processes to reduce contaminant concentrations in Site groundwater over time. This alternative relies on the success of the cover system to prevent or reduce migration of contaminants to groundwater. MNA would further reduce levels of contamination in groundwater over time, but is anticipated to require more cleanup time to achieve RAOs and ARARs than the other alternatives. Use of MNA during the RA would require routine groundwater monitoring of the various plumes, periodic data evaluations to track the progress of natural attenuation, and implementation of an adaptive management strategy. MNA also would require ICs to restrict groundwater use until the cleanup levels are achieved.

GW 3—Limited Permeable Reactive Barrier Treatment of Alluvial Groundwater, Monitored Natural Attenuation, and Institutional Controls

Estimated Cost/Time	
Capital Costs	$727,004
Institutional Control Costs	$125,000
Total O&M Costs (30 years)	$1,004,968
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$2,073,000
Construction Time Frame	5 to 10 years (constructed concurrent with cover)
Time to Achieve RAOs	10+ years after cover construction

Under this alternative, PRBs would be constructed near the margins of waste rock dumps to intercept and treat shallow alluvial groundwater along selected flowpaths. The PRBs would be upgradient of perennial seeps/springs. PRBs would include a mixture of organic and inorganic materials to treat mine-affected groundwater before it discharges at the seep/spring location where exposures can occur. In some cases, where the affected alluvial groundwater is excessively deep, extraction wells may supplement the system and discharge to the PRB. MNA and ICs would supplement other primary elements of the remedy (source controls and treatment) to achieve cleanup levels in mine influenced groundwater. Under this alternative, MNA is considered a polishing step for contaminants in groundwater and for monitoring the effectiveness of the primary elements of the remedy that will control releases of contaminants to groundwater.

GW 5b—Groundwater Recovery and Treatment of both Alluvial and Wells Formation Groundwater and Institutional Controls

Estimated Cost/Time	
Capital Costs	$15,271,969
Institutional Control Costs	$100,000
Total O&M Costs (30 years)	$8,631,241
Total Periodic Costs (30 years)	$215,770
Total Present Value Costs	$24,219,000
Construction Time Frame	5 to 10 years (constructed concurrent with cover)
Time to Achieve RAOs	10+ years after cover construction

This alternative includes extraction and treatment of all mine-influenced groundwater, including the alluvial and Wells Formation groundwater (deep regional water). Robust ICs would accompany the remedial action. It is assumed that extraction trenches, or a limited number of extraction wells in areas of deep alluvium, could be used to remove mine-affected alluvial groundwater upgradient of the perennial seeps/springs and in appropriate downgradient locations on the east and west sides of the Site. Extraction wells would be used to remove groundwater from the Wells Formation.
The extracted groundwater would be treated using a physical, chemical, or biological treatment system (for the Wells Formation either alone, or in combination with alluvial water). Extracted and treated water from

the Wells Formation would be returned to the Wells Formation through engineered infiltration wells. Extracted and treated water from the alluvial aquifer would be discharged to a constructed basin and allowed to infiltrate back into the alluvial aquifer.

Comparative Evaluation of Alternatives

The Superfund regulations require that alternatives be evaluated using the nine criteria presented on page 26. As described in the inset box, the nine criteria are organized into three groups: Threshold Criteria; Primary Balancing Criteria; and Modifying Criteria.

Using these criteria, the alternatives (that were carried forward following screening) are evaluated in detail independently, and then compared to identify the relative advantages and disadvantages. This section summarizes the results of this evaluation for each media. A more thorough evaluation of the alternatives in relation to each criterion is provided in the FS.

Overall Protection of Human Health and the Environment (Threshold Criterion)

All action alternatives for each medium are expected to be protective of Human Health and the Environment. An alternative is protective if it achieves RAOs though some combination of engineering controls, treatment, and institutional controls. Key findings of the detailed and comparative evaluations for media-specific alternatives are summarized below.

As required by the NCP, a No Action Alternative was developed to provide a baseline for comparing other alternatives. The No Action Alternative (Alternative 1 for each medium) would not be protective of Human Health and the Environment. Contaminants in source materials would continue to be released and transported to nearby surface water, groundwater, and sediment/riparian soils. Risks associated with exposure to waste rock and vegetation would remain. RAOs and PRGs for various contaminants would not be achieved and is not discussed further.

Upland Soil/Waste Rock

All action alternatives (USWR 4, 6, and 7) for upland soil/waste rock would be protective of Human Health and the Environment. These alternatives all include a similar remedial strategy consisting of a combination of grading and consolidation of waste materials, construction of an ET cover system over more than 500 acres of mining disturbance, ICs, O&M, and LTM. The primary difference between the alternatives is the amount of earthwork, such as grading and consolidation of waste materials, and the extent to which open pits are backfilled. In addition, USWR 6 would allow for recovery of phosphate ore during implementation of the remedy.

Nine Superfund Evaluation Criteria

Threshold Criteria (2)—Must be Addressed

1. Overall Protection of Human Health and the Environment evaluates whether an alternative eliminates, reduces, or controls threats to public health and the environment through institutional controls, engineering controls, or treatment.
2. Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the Site, or whether a waiver is justified.

Primary Balancing Criteria (5)

1. Long-term Effectiveness and Permanence considers the ability of an alternative to maintain protection of human health and the environment over time.
2. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment evaluates an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.
3. Short-term Effectiveness considers the length of time needed to implement an alternative and the risks the alternative poses to workers, the community, and the environment during implementation.
4. Implementability considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.
5. Cost includes estimated capital and annual operations and maintenance costs, as well as present value cost. Present value cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

Modifying Criteria (2) —The modifying criteria will be evaluated following comments received during the public comment period and will be addressed in making the final remedy decision and discussed in the ROD.

1. State/Tribal Acceptance considers whether the State and affected Tribes agree with EPA's analyses and recommendations, as described in the RI/FS and Proposed Plan.
2. Community Acceptance considers whether the local community agrees with EPA's analyses and preferred alternative. Comments received on the Proposed Plan are an important indicator of community acceptance.

For each alternative, RAOs would be achieved by isolating the source materials (upland soil, waste rock, and exposed ore beds) under an ET cover system that would prevent direct exposure of people and wildlife to COCs. The cover system would provide clean growth medium for vegetation that would address risks associated with ingestion of vegetation that contains elevated levels of selenium. The alternatives would also stabilize waste materials, and reduce concentrations of COCs in source materials to downgradient groundwater, surface water, and sediment/riparian soil. ICs would be applied to restrict the use of groundwater, further restrict access, and to protect the integrity of the remedy.

Surface Water

Surface water alternatives SW 2 and SW 3 would be protective of human health and the environment. Both alternatives rely on source control through the USWR alternatives. Implementation of one of the USWR alternatives would result in two important effects. First, snowmelt and runoff from the mining disturbance would no longer come into contact with source materials, and any surface runoff to nearby intermittent streams will meet RAOs. Second, the engineering controls should also greatly reduce the infiltration of precipitation through waste rock, which over time will reduce or eliminate the flow of springs and seeps near the waste rock dumps and the concentration of COCs in remaining seeps and springs. Both alternatives also include ICs and fencing to limit access until the USWR engineering controls become fully effective. The key difference between the two SW alternatives is that SW 3 also includes the capture and treatment of residual seepage prior to discharge into downstream intermittent drainages using constructed in situ biological treatment cells. SW 3 is more effective in the short term than SW 2, which relies on source control alone to achieve RAOs.

Stream Channel Sediment and Riparian Soils

Two alternatives (S/RS 3 and S/RS 4) were considered to address impacts to sediment and riparian soil. Both would achieve ARARs by being protective of human health and the environment, and rely on source control through implementation of one of the USWR alternatives to minimize the delivery of contaminated particles to downgradient intermittent stream and riparian areas.

S/RS 3 includes: Sediment Traps/Basin, MNR, ICs. Sediment traps and settling basins would be constructed to capture sediment leaving the Site during construction of the soil cover. Once the source of contamination is controlled, natural recovery is the mechanism for further reducing contamination to protective levels. A monitoring program will be established to track progress. ICs will be applied to limit access to impacted areas until cleanup levels are achieved. An adaptive management plan will provide a structured process for making management decisions to improve remedy performance.

S/RS 4 is similar to S/RS 3, except that contaminated sediment and riparian soil would be removed from most contaminated reaches of the intermittent and ephemeral drainages. S/RS 4 would disturb habitat during construction and complete restoration is uncertain.

Groundwater

Three alternatives (GW 2, GW 3, and GW 5b) were considered to address impacts to groundwater. All would be protective of human health and the environment over time. GW 3 and GW 5b, however, which include remedial treatment technologies, would likely meet ARARs more quickly than GW 2. All three rely upon source control through implementation of the USWR alternatives to limit infiltration.

GW 2 would include MNA and ICs. Once the release and transport of COCs from the source areas are controlled by the cover system, natural attenuation is the mechanism for achieving protective levels over time. A monitoring program would be established to track progress. ICs would be applied to restrict well drilling and use of groundwater in impacted areas. An adaptive management plan would be developed to provide a structured process for evaluating progress and making defensible management decisions to improve overall remedy performance.

GW 3 includes the elements of GW 2, and also includes use of PRB treatment of alluvial groundwater along selected flowpaths. Under this approach, RAOs in shallow groundwater would be achieved sooner than GW 2.

GW 5b includes the recovery and treatment of alluvial and Wells Formation groundwater and ICs.
This approach is expected to meet RAOs by removing contaminants from areas of impacted groundwater and restricting use until cleanup levels are achieved.
A number of technical factors (such as the influence of geologic structures on groundwater flow direction) introduce some uncertainty into the effectiveness of this approach.

ARARs (Threshold Criterion)

All action alternatives for each medium will attain ARARs under federal environmental laws and state environmental or facility-siting laws. Key ARARs are discussed below. The FS includes a complete list preliminary ARARs and a discussion of how the alternatives will comply.

Key ARARs at the Ballard Mine

- Idaho Water Quality Standards, including water quality criteria.
- CWA, Section 404 (compliance requirements for designated waters of the United States)
- National Recommended Water Quality Criteria established under the CWA.
- National Primary Drinking Water Regulations, including MCLs, established under the Safe Drinking Water Act.
- Idaho Ground Water Quality Rule.
- Portions of the regulations established under Uranium Mill Tailings Radiation Control Act (UMTRCA).
- Regulations established under the Mineral Leasing Act that control the development and reclamation of phosphate mines.
- Regulations under the Idaho Surface Mine Reclamation Act pertaining to reclamation of surface mining operations.

Chemical-specific ARARs that strongly influenced the development of alternatives included the state and federal water quality criteria for surface waters and MCLs for groundwater. PRGs for these media are based on these ARARs. In general, all SW and GW alternatives are expected to comply with key ARARs, with no significant difference between alternatives. Achieving ARARs for groundwater and surface are the action-driving requirements of the remedy and led to development of the source controls described in the alternatives.

Action-specific ARARs that influenced the development of alternatives included state and federal mining and reclamation requirements. These ARARs establish performance requirements for the remediated areas including the source areas and intermittent and ephemeral drainages to ensure the effectiveness and integrity of the cleanup actions. In general, all USWR and S/RS alternatives are expected to comply with key ARARs. For S/RS, ARARs will more readily be achieved by S/RS 3, which relies on monitored natural recovery to reclaim impacted reaches. This alternative also complies with Section 404 of the CWA, which requires any mitigation sequence to avoid, and minimize disturbances to riparian areas (wetlands).

Long-term Effectiveness and Permanence (Balancing Criterion)

The retained **Upland Soil/Waste Rock** Alternatives (USWR 4, USWR 6, and USWR 7) are similar. They all include: excavation, consolidation, or grading, followed by construction of a cover system to meet RAOs. All use ET covers constructed with natural material for long-term durability. USWR 6 includes recovery of phosphate ore during RA, which is a unique difference from USWR 4 and USWR 7. All alternatives are expected to function effectively and be resilient under various climate change scenarios. All candidate alternatives will achieve long-term effectiveness and permanence.

The ore recovery in USWR 6 would generate additional waste rock to be managed, but would be offset by several benefits related to long-term effectiveness. Much of the additional waste rock would be used to backfill existing mine pits, and some may be suitable for use in construction of the cover system. USWR 6 includes more natural and contiguous landforms that blend into the adjacent uplands and more effectively shed surface runoff from the cover system and site. Because of these factors, USWR 6 carries advantages in long-term effectiveness over the other alternatives.

The candidate alternatives for **Surface Water**, SW 2 and SW 3, both rely on construction of a cover system over all waste rock/soil source areas to prevent stormwater and snowmelt runoff from contacting contaminants (in waste rock). With the cover system in place, over the long term, stormwater flowing from the Site should ultimately meet the surface water cleanup levels for Site contaminants. The sediment basins and wetland treatment cells associated with SW 2 and SW 3 are intended as temporary measures. SW 3 carries an advantage (in situ wetland treatment cells and ICs) over SW 2 (ICs only) because it incorporates additional treatment of contaminated seepage using the constructed wetlands. The wetland treatment cells can be left in place until mine-affected surface water discharging from the seeps/springs diminishes or achieves PRGs.

The retained **Sediment/Riparian Soil** alternatives (S/RS 3 and S/RS 4) offer different remedial strategies that carry advantages and disadvantages. S/RS 3 would rely on sediment basins constructed in the upper reaches of the mine-affected drainages to capture sediment entrained in runoff, combined with MNR, whereas S/RS 4 relies on excavation of contaminated sediment and riparian soils from the areas close to the mine dumps and MNR for reaches further from the Site. Both include implementation of ICs. With respect to long-term effectiveness, Alternative 4 is ranked higher because the contaminated sediment is physically removed from the upper reaches of the drainage; however, this is offset by uncertainty over recovery of ecological functions and values in the area that would be excavated.

For **Groundwater,** all retained alternatives (GW 2, GW 3, and GW 5b) rely heavily on the cover system described earlier. The additional elements in the retained alternatives would address releases to groundwater until the cover system is functioning effectively and to address contamination that has already been released to groundwater. GW 3 (includes PRBs and MNA) and GW 5 (includes pumping) rank similarly with respect to long-term effectiveness and permanence, and higher than GW 2 (MNA, ICs). GW 2 and GW 3 would use MNA as a polishing step to reduce the concentration of contaminants already released to groundwater, primarily through dilution and dispersion. GW 3 and GW 5b have potential to reduce contaminant mass in a relatively short time frame. In addition, the extraction and injection technologies associated with GW 5b are more difficult to implement and maintain long term.

Reduction of Toxicity, Mobility or Volume of Contaminants through Treatment (Balancing Criterion)

For **Upland Soil/Waste Rock,** all Alternatives (USWR 4, USWR 6, and USWR 7) reduce contaminant mobility by isolating source material under a similar cover, but none reduce toxicity, mobility, or volume of contamination through treatment.

For **Surface Water**, SW 3 ranks higher than SW 2 with respect to this criterion. Under Alternative 3, discharges from seeps/springs would be collected and treated during the years of remedial construction (assuming the wetlands are installed early during the RA) and in the post-construction period before the seeps/springs either go dry or meet the cleanup levels because of source controls. SW 2 relies primary on source controls, and does not include treatment.

For **Sediment/Riparian Soil,** neither of the retained alternatives provides treatment; however, S/RS 4 would result in the greatest reduction in mobility because some contaminated sediment is removed through excavation, reducing the amount of contaminants available for remobilization.

For **Groundwater,** GW 5b includes extraction and treatment of mine-affected groundwater. GW 3 treats shallow groundwater by installing PRBs along selected flowpaths near the source areas. GW 2 doesn’t actively treat groundwater.

Short-term Effectiveness (Balancing Criterion)

Under short-term effectiveness, all three **Upland Soil/Waste Rock** alternatives involve similar construction practices and protect community and workers during implementation of the remedy. For all alternatives, RAOs would be met at the end of construction. The alternatives require different amounts of time to implement and achieve RAOs, with USWR 4 achieving RAOs in 3 to 5 years, and USWR 6 requiring 6 to 8 years.

For Surface Water, SW 2 employs ICs (combined with the cover system) as the remedial action. In the short term, ICs and fencing are easy to implement, and prevent contaminant exposures. Time to attain of PRGs would depend on the construction schedule for the cover system. SW 3 requires the construction of sediment berms/basins and wetland treatment cells. PRGs would be met more quickly under SW 3. Thus, SW 3 has advantages over SW 2 with respect to this criterion.

For **Sediment/Riparian Soil,** S/RS 3 (which relies on sediment traps and MNR) ranks high because of the shorter construction time and the fact it would be less intrusive to stream drainages. S/RS 4 (which involves excavation of some sediment and riparian soil) would harm ecological functions and values in the short-term in the reaches of intermittent streams that are excavated. These corridors would need to be reconstructed, introducing uncertainty about the length of time needed to recover ecological functions and values. Because of the additional construction work associated with S/RS 4, there is increased risks to workers.

For Groundwater, all of the alternatives depend on source controls described in the upland soil/waste alternatives and would require many years to achieve cleanup levels. GW 5b and GW 3 include removal of contaminants through treatment in the short-term, and thus are likely to achieve PRGs quicker than GW 2.

Implementability (Balancing Criterion)

Upland Soil/Waste Rock Alternatives (USWR)

Each of the upland soil/waste rock alternatives includes moving large volumes of earth, which is technically feasible because equipment and expertise are locally available. Under USWR 6, specialized mining expertise and equipment is required and available. USWR 4 and USWR 7 rank higher than USWR 6 in administrative feasibility. The ore recovery component of USWR 6 and the required coordination with BLM (for mineral leasing and mine plan approval) and the State adds an additional level of administrative complexity.

The services and materials required to implement USWRs 3, 6, and 7 are similar except for the recovery of ore associated with USWR 6 which requires specialized excavation equipment and transport vehicles to safely haul ore from the mine to the processing facilities. Therefore, USWR 6 is ranked below USWR 4 and 7.

Surface Water Alternatives (SW)

SW 2 offers no technical implementability challenges because its remedial action includes application of ICs. SW 3 involves the strategic placement and construction of wetland treatment cells in addition to MNR, and ICs, making it the more challenging to implement and resulting in a lower ranking than SW 2.

All surface water alternatives require a wetlands inventory and assessment to comply with Section CWA 404b. A compliance memorandum will be prepared to track baseline conditions through remedial action to assure substantive compliance with the CWA. Because it involves construction within riparian corridors, SW 3 is more challenging to implement.

Most of the services, materials, and equipment associated with the implementation of SW 2 and 3 would be available regionally. Specialized services required by SW 3 for the design of engineered wetlands would be more difficult to obtain; therefore, SW 3 is ranked below SW 2 in availability of services and materials.

Sediment/Riparian Soil Alternatives (S/RS)

S/RS 3 proposes MNR, and ICs, while S/RS 4 includes removal of stream channel sediment and riparian soil and disposal at an approved location under the ET cover. The higher level of construction activity and effort and complexity associated with reconstructing excavated corridors results in S/RS 4 ranking lower than S/RS 3, with respect to technical feasibility. Because wetlands inventory and assessment (as well as a CWA 404b compliance memo) is needed for all alternatives, it does not affect the rankings.

Most of the services, materials, and equipment associated with the implementation of S/RS 3 and 4 would be available regionally. It's likely that work under S/RS 4 would be performed in conjunction with the equipment used for the construction of the ET cover. S/RS 3 requires less service and material to implement; therefore, it is ranked higher than S/RS 4.

Ground Water Alternatives (GW)

GW 2 (MNA, and ICs) ranks highest with respect to technical feasibility because no construction or O&M are required. GW 3 (PRBs, MNA, and ICs) and 5b (pump and treat) follow, respectively, with construction, O&M, and additional infrastructure needs.

Technical feasibility challenges associated with groundwater GW 3 and 5b are installing the treatment cells, extraction wells, and treatment equipment specific to each reclamation alternative. These alternatives are considered equivalent in technical implementability, and ranked below groundwater Alternative 2.

Spent reactive barrier media generated by groundwater movement through the PRB may need to be stabilized or treated prior to placement in an onsite repository. Wastes associated with treatment by membrane technology would also require disposal in an approved manner. GW 2, with no sludge or waste disposal, would rank higher than GW 3 and 5b.

Most of the services and materials associated with the implementation of each of the GW Alternatives would be available regionally. However, specialized drilling services and treatment equipment and dedicated facility required by GW 5b would be more difficult to obtain than the other equipment associated with implementation of GW 3; therefore, GW 5b is ranked below GW 3 in availability of services and materials.

Cost (Balancing Criterion)

Cost represents the balancing criteria that most clearly differentiates the alternatives. For remediation of **Upland Soil/Waste Rock**, USWR 7 is the most expensive at $113 million. The estimated cost of USWR 4 is $51 million, whereas the cost of USWR 6 is estimated to be $36.9 million.

Surface Water Alternative 2 (ICs) is easy to implement and has low costs ($850,000) because it doesn't include design, construction, or O&M of remedial actions. SW 3 (In situ Biological Treatment Wetlands) has moderate costs ($1.4 million).

Sediment/Riparian Soil Alternative 3 ($736,000; MNR focused) costs less than S/RS 4 ($1.59 million; includes excavation in addition to MNR).

For **Groundwater,** Alternative 2 ($1.4 million; MNA and ICs) is the least expensive option. GW 3 ($2.1 million; PRBs) requires more construction, but remains close in cost to GW 2. GW 5b would likely achieve RAOs more quickly, but at a higher cost, assuming an effective extraction well network could be constructed in the deep Wells Formation. GW 5b is substantially more expensive ($24 million; more than 10 times) than GW 3.

State and Tribal Acceptance (Modifying Criterion)

The State of Idaho (through IDEQ) has been an active participant and fully engaged throughout the remedial investigation, feasibility study process, and development of the preferred alternative. To date, State concerns have been addressed and the State is in agreement with the progress of the project and the remedial action proposed for the site. IDEQ will provide its comments on the Proposed Plan during the public comment period, including comments on the appropriate cleanup goal for arsenic in surface water. Final State acceptance will be evaluated after the public comment period ends and will be described in the ROD. EPA will carefully consider comments received from the State during the public comment period when selecting a final remedy in the ROD.

As a support agency, the Shoshone-Bannock Tribe has been actively engaged throughout the RI/FS. EPA will carefully consider comments received during the public comment period and will offer to consult with the Tribes prior to starting the comment period.

Community Acceptance (Modifying Criterion)

EPA and Support Agencies have met with stakeholders and interested members of the community over time, including interviews during development of the community involvement plan for the project. Some key themes that were expressed during these meetings and interviews included support to make progress on addressing the problems, and caution to not take actions that would harm the local economy.

EPA will seek comments on the Proposed Plan and RI/FS during the public comment period. Community concerns will be considered by the EPA during preparation of the ROD. The ROD will include a Responsiveness Summary of all comments received on the Proposed Plan.

Preferred Alternative

The Preferred Alternative for the Site is a combination of USWR 6 (Grading and Consolidation, Incidental Ore Recovery, Evapotranspiration Cover System, Institutional Controls, and Operations and Maintenance/Long-term Monitoring), SW 3 (In Situ Biological [Wetlands] Treatment of Source Area Seepage), S/RS 3 (Sediment Traps/Basins, Monitored Natural Recovery, and Institutional Controls), and GW 3 (Limited Permeable Reactive Barrier Treatment of Alluvial Groundwater, Monitored Natural Attenuation, and Institutional Controls).

The media-specific alternatives selected as components of the Preferred Alternative are described in more detail in the FS. The preferred combined alternative also includes minor modifications and clarifications to the FS related to adaptive management planning, long-term monitoring and the Ballard Shop area, and are described next.

The combined preferred alternative described in this proposed plan may change in response to public comment or new information.

Elements of the Combined Preferred Alternative

The following sections describe the elements of the combined Preferred Alternative and how the media-specific elements work together to achieve RAOs. The relationship between the elements of the combined remedy are illustrated in conceptual cross sections shown in Figures 8 and 9. A summary of costs associated with the Preferred Alternative is presented in Table 5.

Upland Soil/Waste Rock

The cornerstone of the Preferred Alternative is the engineering controls proposed for upland soil and waste rock. These source controls include grading and consolidation of waste rock, and construction of an ET cover system over approximately 538 acres. Implementation would be coordinated with ore recovery activities.

The source controls fundamentally address the source of contaminants found in all impacted media. The ET cover would prevent or greatly reduce release of contaminants to surface water and groundwater. The cover would also address direct contact exposures with the underlying waste rock, prevent vegetative uptake in the upland areas of the site, and control releases of contaminants to riparian soil/sediment. LTM would be implemented to evaluate the effectiveness of the cover system over time, and maintenance actions would be implemented to correct problems and to ensure the integrity of the cover. ICs would be implemented to protect the integrity of the remedy and ensure that future land uses are appropriate.

Collectively, this combination of engineering controls, LTM, and ICs are expected to result in waste rock and upland soil meeting RAOs, and will significantly contribute to achievement of RAOs for all other media.

Surface Water

Mine-affected surface water at the Site includes: (1) stormwater/snowmelt runoff and discharge to the drainages downgradient of the mined area, and (2) intermittent and perennial seeps/springs that discharge to the ground surface located at or near the margins of the existing waste rock dumps.

Figure 8. Proposed Remedial Elements of the Combined Preferred Alternative

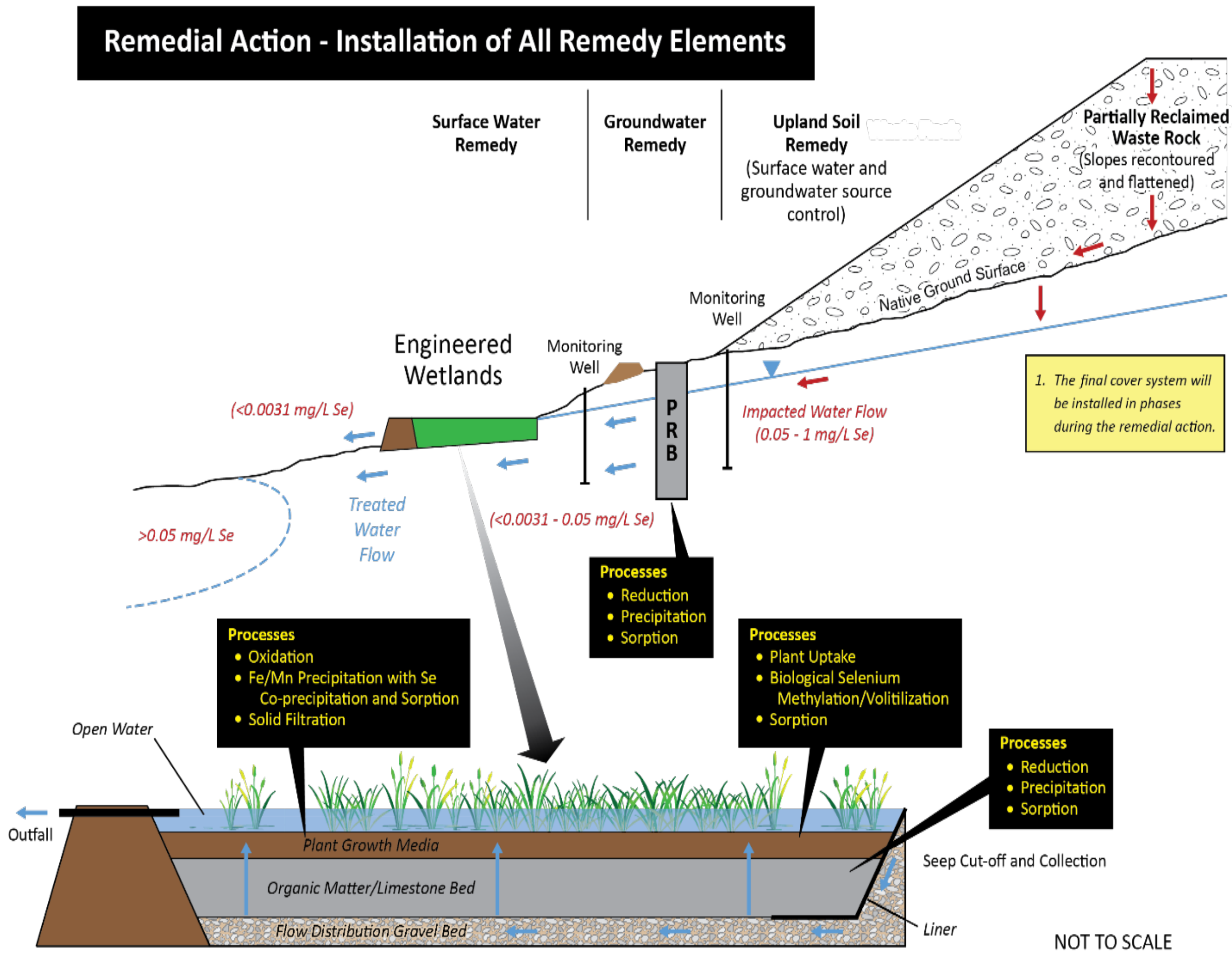
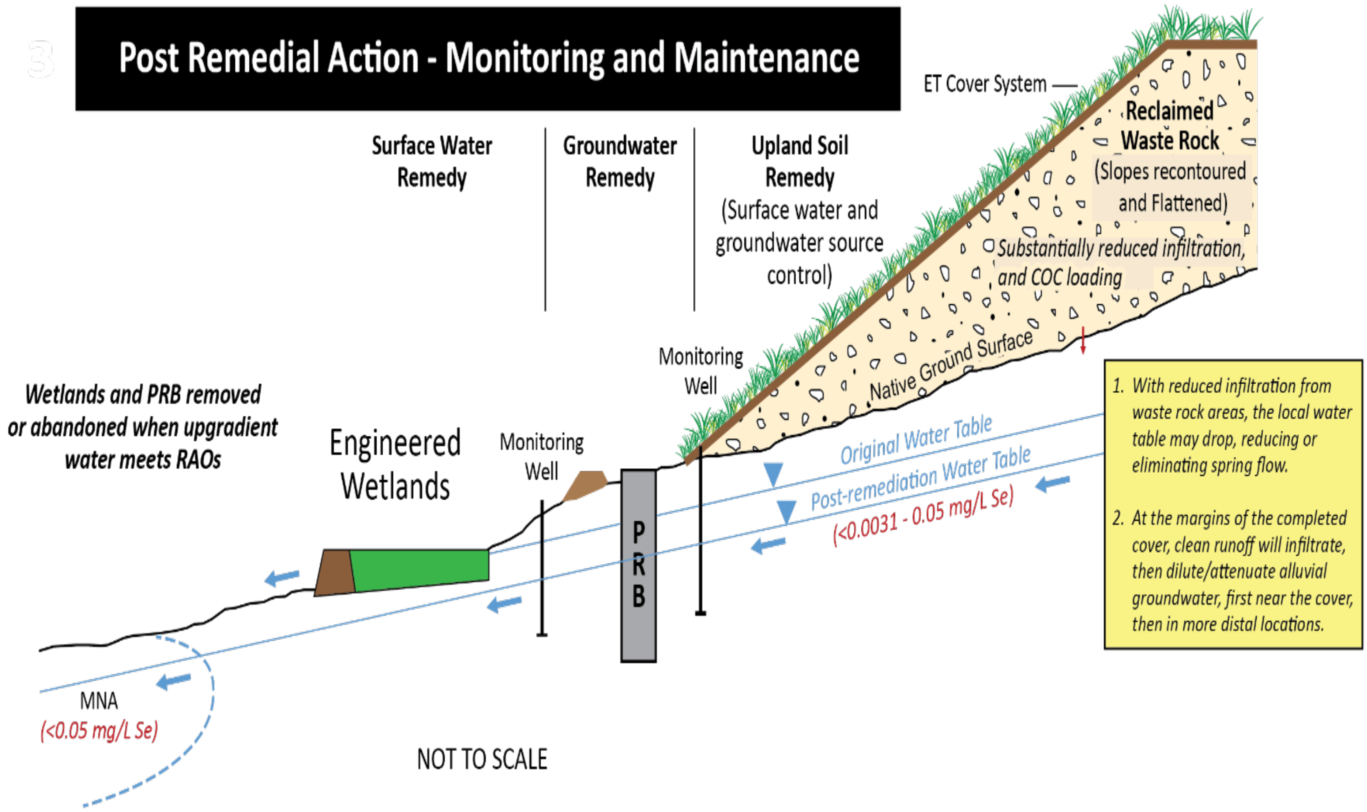


Figure 9. Proposed Combined Preferred Alternative after Remedial Construction



Once the ET cover system is constructed, stormwater and snowmelt will no longer contact contaminated waste material before entering nearby drainages. This unimpacted stormwater runoff is expected to meet PRGs. During the construction phase, sediment ponds and other sediment control BMPs would be constructed to control release of sediment to downstream waterbodies.

The ET cover system will substantially reduce precipitation and snowmelt from infiltrating through the waste rock. This reduction in recharge will result in the drying up of most of the existing seeps/springs as residual water in the waste rock drains through the hydrologic system. In the case of perennial springs with a groundwater source, the reduced contaminant flux from the waste rock would quickly result in improved water quality. During the phased implementation of the waste rock cover, mine-affected seeps/springs would be captured and treated using engineered wetlands. In some locations, the treatment effectiveness of the wetlands, would be enhanced by PRBs installed to treat the shallow alluvial groundwater upgradient of its discharge at the seep locations (refer to Figure 9). In these locations, the wetland treatment cells would be installed as a polishing step to bring contaminants in the groundwater down to surface water PRG (for example, 0.003 mg/L for total selenium). Unimpacted surface water from the cover system would also be channeled around any seeps/springs that are undergoing treatment in engineered wetlands. The PRBs and wetland treatment cells will be removed when no longer needed, unless it is shown that leaving them in place will not cause problems. Decision rules for determining whether the wetland treatment cells and PRBs may remain in place will be developed and included in the adaptive management plan to be prepared during remedial design. The contaminated treatment media would be disposed of onsite and capped. As PRBs and wetland treatment cells are maintained, spent treatment media would also be disposed of onsite in a similar fashion.

Site access near the mine-affected seeps/springs would be limited by ICs and fencing. LTM would be integrated into the remedy and used to evaluate the performance of the wetlands and to determine when the RAOs have been achieved in the seeps/springs. A sitewide adaptive management plan will be used to determine the efficacy of the selected remedy and make adjustments to the remedial approach, where warranted.

Collectively, this combination of engineering controls, treatment of selected mine-influenced waters, and ICs are expected to result in surface water meeting RAOs.

Sediment/Riparian Soil

Remediation of sediment and riparian soil includes installation of sediment traps/basins in headwater drainage locations and MNR for drainage reaches located downstream of the Site. The sediment basins will be decommissioned after the cover system is constructed, revegetated, and functioning. MNR is considered a feasible remedial alternative for these media because the recommended upland soil/waste rock ET cover would prevent contaminant source material from being transported offsite and into these drainages. Without an ongoing source of mine-related constituents, the sediment/riparian soil in the downstream drainages would disperse and/or be covered naturally over time by vegetation detritus, windblown dust, and clean sediment entering these headwater drainages from surrounding reclaimed upland surfaces. Over time, these processes are expected to result in natural recovery of these impacted areas and attainment of RAOs. LTM would be conducted at strategic sampling stations throughout the reach of impacted stream channels and down to below their confluence with the Blackfoot River to track progress toward meeting RAOs. These sampling stations would be located in vulnerable areas such as where ponding and sediment deposition is known to occur.
A sitewide adaptive management planning approach will be used to evaluate progress and trigger follow-up actions as needed. None of these modifications are anticipated to constitute a significant or fundamental change to the remedy selected in the ROD.
This alternative would include ICs to limit access and restrict certain activities (for example, harvesting culturally significant plants) until it can be demonstrated that natural recovery has occurred.
The length of time required to meet cleanup levels is dictated by the progress of associated upgradient remedial activities.

Groundwater

The proposed remedy for groundwater includes a combination of PRBs, MNA, and ICs for mine-influenced groundwater, in conjunction with source controls in the upland soil/waste rock.

The primary element of the strategy to restore groundwater is the implementation of source controls described in the upland soil and waste rock alternative. These actions should substantially reduce the release of contaminants to groundwater. Without an ongoing source of contamination, contaminant concentrations in groundwater will, over time, be reduced through the mechanisms of dilution, attenuation, and dispersion.

To treat shallow alluvial groundwater, and more quickly achieve PRGs, PRBs would be installed at strategic locations along the margins of the cover, upgradient of mine-influenced perennial seeps/springs. The objective of the PRBs is to reduce contaminant concentrations in shallow alluvial groundwater in the short term. As necessary, shallow groundwater that discharges as contaminated seeps and springs will be collected and routed to wetland treatment cells to achieve surface water PRGs (see Figure 9).

PRBs would be removed when no longer needed, unless it is shown that leaving the PRBs in place will not cause problems. Decision rules for determining whether PRBs may remain in place will be developed and included in the adaptive management plan to be prepared during remedial design. The contaminated treatment media would be disposed of onsite and capped.

MNA will be used as a polishing step to address contamination that has already been released to shallow groundwater. MNA would rely on dilution and dispersion over time as the primary mechanisms to reduce the concentration of contaminants. Sorption of contaminants to aquifer materials is a secondary mechanism that may further reduce concentration of contaminants in the groundwater. Multiple lines of evidence were considered in developing this approach. LTM would be conducted at strategic sampling locations in all groundwater contaminant plumes to track progress toward meeting PRGs. A sitewide adaptive management planning approach will be used to evaluate progress and trigger follow-up actions, as needed.

There are also observed impacts to the deeper Wells Formation aquifer in the southwest portion of the site. To address these impacts, the Preferred Alternative relies on the cover system in the upland soil/waste rock alternative to prevent or reduce migration of contaminants to groundwater. Residual impacts to the Wells Formation, once the source of contamination is eliminated, would be addressed by MNA, with dilution and dispersion expected to be the primary mechanisms to reduce the concentration of contaminants over time.

ICs will be implemented on all P4-owned lands, and as necessary, on private land adjacent to the Site through legally binding agreements to restrict withdrawal and use of groundwater until cleanup levels are achieved.

Summary of Alternative Costs

The Preferred Alternative for the Site consists of a combination of media alternatives, the total cost of which are presented in Table 5.

Institutional Controls

The Preferred Alternative includes several types of ICs, which are intended to minimize the potential for people to be exposed to contamination by limiting land or resource use, and to maintain the integrity of the engineered components of the remedy. Specific examples of ICs include easements and covenants to restrict land use, water use, and restrict drilling wells for domestic use and the like. In addition, fencing to limit off-road vehicles, warning signage, locked gates, and other measures will be utilized to control access.
The ROD will provide a more detailed description of ICs.

Operation and Maintenance

O&M is an integral part of every media-specific element of the Preferred Alternative and is necessary to ensure the integrity of engineering controls, such as the ET cover system and the proper functioning of treatment facilities (PRBs and wetlands). The specific O&M requirements vary depending on the cleanup method or technology and will be developed during remedial design (such as, fixing ET cover erosion, or enhancing vegetation coverage).

Long-term Monitoring

Monitoring will be conducted to assess the effectiveness of various components of the remedy. The monitoring program will include: periodic inspections of site conditions, sampling and analysis of groundwater, surface water, sediment, riparian soil, vegetation, and upland soil. Specific data quality objectives and requirements for sampling will be developed during remedial design.

Adaptive Management Plan

A sitewide adaptive management plan for the Ballard Site will be developed and implemented to evaluate and monitor critical elements of the remedy, and determine if additional designs, design modifications, or operational changes are necessary to achieve RAOs. For example, the Adaptive Management Plan would prescribe a strategy for using collected data to assess the effectiveness of MNR and MNA based on project criteria. If evaluations conclude that RAOs would not be achieved in a reasonable time frame, remedial actions would be adapted to improve their effectiveness.

Table 5. Media – Preferred Alternative Costs

Media – Preferred Alternatives	Est. Total Capital Costs	Estimated Total O&M Costs (First 30 years)	Estimated Total Periodic Costs (First 30 Years)	Estimated Construction Time Frame	Estimated Total Media Alternative Cost (Present Value)
Upland Soils/Waste Rock (USWR 6)	$147,292,914	$388,294	$215,770	6 to 8 years	$36,974,250
Sediment/Riparian Soil (S/RS 3)	$240,433	$204,216	$215,770	5 to 10 years	$736,000
Surface Water (SW 3)	$576,835	$589,254	$215,770	5 to 10 years	$1,432,000
Groundwater (GW 3)	$727,004	$1,004,968	$215,770	5 to 10 years	$2,073,000
TOTAL					$41,215,250

The adaptive management plan will be developed for the comprehensive sitewide alternative during remedial design; however, any modifications would not fundamentally change the remedy components or ability to achieve remedial action objectives.

Ballard Shop Area

The Ballard Shop area will continue to be used for many years by P4 to support remedy implementation and nearby mining operations. Anticipated uses include storage of vehicles, equipment and materials, storage of fuel, and other related uses.

The preferred remedy includes ICs and fencing where prudent to limit potential exposures to construction and mine workers. ICs will include restrictions on the use of this area and groundwater. A focused FS and proposed remedy will be developed for this small portion of the Site in the future, and a final remedy selected in a separate ROD.

How the Preferred Alternative would be Implemented

The Preferred Alternative would be implemented in phases: (1) planning and design; (2) earthworks and construction; and (3) long-term monitoring, optimization guided by the adaptive management plan, and O&M.

The **initial phase** involves detailed planning and design of the remedy. This phase would occur following formal selection of a remedy in the ROD. ICs would be implemented during this initial phase. The responsible party (P4) would also coordinate with BLM and State land managers to complete actions and authorizations necessary to recover remaining ore at the site, such as the issuance of a mineral lease by BLM and authorization of a mine plan for recovering ore. These separate actions and authorizations are necessary because the CERCLA process focuses on cleanup actions, and a ROD would not explicitly authorize recovery of the leasable phosphate remaining at the site. In addition, the CERCLA 121(e) permit exemption does not apply to BLM mineral leasing and mine plan authorization requirements.

During the remedial design, plans for sequencing of ore recovery and remediation activities may be modified to optimize implementation based on new information and any necessary pre-design studies; however, any modifications would not fundamentally change the remedy components or ability to achieve remedial action objectives.

The **second phase** involves construction of the remedy. This phase would be implemented in three construction phases, aligning with recovery of phosphate ore from three areas of the site. The overall timeline for construction is estimated to be 6 to 8 years.

The **third phase** involves long-term monitoring, optimization of remedy components guided by the adaptive management plan, and O&M. These activities are expected to continue for several decades until the RAOs are achieved and all remedy components are fully functioning.

Rationale for Selecting the Preferred Alternative

The Preferred Alternative was selected over other combinations of media-specific alternatives using the findings of the nine criteria evaluations in the FS (and summarized in this document). A number of key factors and goals led to selection of the Preferred Alternative. These key factors include:

- The upland soil/waste rock alternative provides a similar level of protectiveness compared to the other two alternatives, but costs significantly less. A significant portion of the cost of earthworks is attributed to ore recovery, which reduces the scope and cost of remaining earthworks associated with implementation of the remedy.
- The surface water alternative collects and treats contaminated seepage near the dumps during the years of remedial construction and in the post-construction period before the seeps and springs dry up or reduce in flow in response to sources controls. Thus, exposures in the short-term are reduced, and the time frame to meet cleanup levels is shortened.
- The wetland cells used for treatment of seeps and springs provides greater reliability that PRGs will be met compared to using the cover system and MNA alone.

- The riparian soil/sediment alternative focuses on sediment-control BMPs and MNR and avoids extensive excavation in the corridors around the intermittent streams near the site. It is uncertain whether ecological function and values can be fully restored in excavated reaches.
- The groundwater alternative treats contaminated groundwater using PRBs along selected shallow alluvial flowpaths near the margins of the site. Thus, short-term human health exposures during construction are reduced, and the time frame to meet PRGs in shallow groundwater is shortened compared to alternatives without PRBs.
- The PRB treatment process would be more adaptable to changing conditions of flow and contaminant concentrations over time as the shallow groundwater system responds to upland/waste rock source controls. PRBs can be maintained as long as they are needed, providing more certainty than the cover system and MNA alternative that RAOs will be achieved.
- The groundwater alternative relies, in part, on MNA as a polishing step to achieve RAOs (the primary strategy to achieve groundwater RAOs is the cover system). It may take 10+ years after remedial construction to achieve RAOs. This is a reasonable time frame, considering the remoteness of the site and the fact that there are no current or anticipated future users (with application of ICs) of the mine-affected groundwater.
- The Preferred Alternative, which relies on a combination of source controls, treatment, MNA and ICs, is expected to restore mining-influenced groundwater to beneficial uses within a time frame that is reasonable.

Summary

On the basis of information currently available, EPA believes the Preferred Alternative meets the threshold criteria and provides the best balance of tradeoffs among the other alternatives with respect to the balancing and modifying criteria. EPA expects the Preferred Alternative to satisfy the following statutory requirements of CERCLA section 121(b):

- Be protective of human health and the environment.
- Comply with ARARs.
- Be cost effective.
- Use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.
- Satisfy the preference for treatment as a principal element (or explain why the preference for treatment will not be met).

Community Involvement

Submitting Comments on the Proposed Plan

Instructions for submitting comments on the Proposed Plan are found on page 1.

Who to Contact with Questions or Concerns

- **U.S. Environmental Protection Agency**
  Dave Tomten, Remedial Project Manager
  (208) 378-5763
  tomten.dave@epa.gov
- **Idaho Department of Environmental Quality**
  Michael Rowe, State Project Manager
  (208) 236-6160
  Michael.Rowe@deq.idaho.gov

Public Comment Period

EPA will accept written comments on this Proposed Plan beginning on April 2, 2018, and ending on May 1, 2018. EPA will make its final decision on the cleanup only after considering public comments. At the end of the comment period, EPA will include a responsiveness summary addressing the comments in the ROD. EPA will place all written comments and the Responsiveness Summary in EPA's Administrative Record for the Ballard Mine Site.

Documents

The Administrative Record for the Site contains the documents that have been used to make decisions on how to clean up the Site. The documents in the Administrative Record can be viewed electronically at the locations listed below, or viewed or downloaded from the project webpage at epa.gov.

EPA Idaho Operations Office
950 W. Bannock Street
Suite 900
Boise, Idaho 83702
Phone: (208) 378-5746
Monday through Friday

DEQ Pocatello Regional Office
444 Hospital Way, #300
Pocatello, ID 83201
(208) 236-6160

Soda Springs Public Library
149 S Main St
Soda Springs, ID 83276-1496
(208) 547-2606

Shoshone-Bannock Tribes Library
P.O. Box 306
Fort Hall, ID 83203
(208) 478-3882

References

Key Guidance Documents

- The National Contingency Plan regulations, found at 40 CFR Section 300, and the statutory requirements of CERCLA—especially Section 121 of CERCLA, 42 U.S.C. Section 9621—are the mandatory requirements that EPA and DEQ must follow in selecting a remedy.
- In addition, EPA uses guidance as appropriate in the remedy selection process. Key guidance documents used for the Ballard Mine are as follows:
  - "A Guide to Selecting Remedial Superfund Actions," OSWER No. 9355.0-27FS (EPA April 1990)
  - "A Guide to Principal Threat and Low Level Threat Wastes," OSWER No. 9380.3-06FS (EPA November 1991)
  - "Rules of Thumb for Superfund Remedy Selection," OSWER No. 9355.0-69 (EPA August 1997)
  - "Incorporating Citizen Concerns into Superfund Decision Making," OSWER No. 9230.0-18 (EPA January 1991)
  - "The Role of Cost in the Superfund Remedy Selection Process," OSWER No. 9200.3-23FS (EPA September 1996)

These and other guidance documents are available at:

- http://www.epa.gov/superfund/resources/remedy/index.htm
- http://www.epa.gov/superfund/resources/policies/index/html.

Key Ballard Mine investigation activities and reports include:

- Idaho Department of Environmental Quality (DEQ). 2004a. Area Wide Risk Management Plan: Removal Action Goals and Objectives, and Action Levels for Addressing Releases and Impacts from Historic Phosphate Mining Operations in Southeast Idaho.
- DEQ, 2017. Community Involvement Plan Update for Ballard, Enoch Valley, and Henry (P4) Mines. March. Prepared by North Wind Resource Consulting.
- Montgomery Harza Watson (MHW). 2002a and 2002b. Area Wide Investigation – Data Summary Reports of Historic Phosphate Mining Operations in Southeast Idaho.
- MWH. 2007. Interim Phase I Site Investigations Evaluation Summary.
- MWH. 2008. Interim Report for Hydrogeologic Investigation Revision 3 – 2007 Hydrogeologic Data Collection Activities and Updated Conceptual Models.
- MWH. 2010. Data Quality and Usability Report (DQUR) and Data Approval Request (DAR). Final Revision 2.
- MWH. 2011. Ballard, Henry and Enoch Valley Mines, Remedial Investigation and Feasibility Study Work Plan.
- MWH. 2013a. Background Levels Development Technical Memorandum, Ballard, Henry, and Enoch Valley Mines, Remedial Investigation and Feasibility Study.
- MWH. 2013b. Final Ballard, Henry, and Enoch Valley Mines, Remedial Investigation and Feasibility Study, 2010-2012 Data Summary Report.
- MWH. 2014. Ballard Mine Remedial Investigation and Feasibility Study, Remedial Investigation Report, Baseline Risk Assessment Addendum, Final.

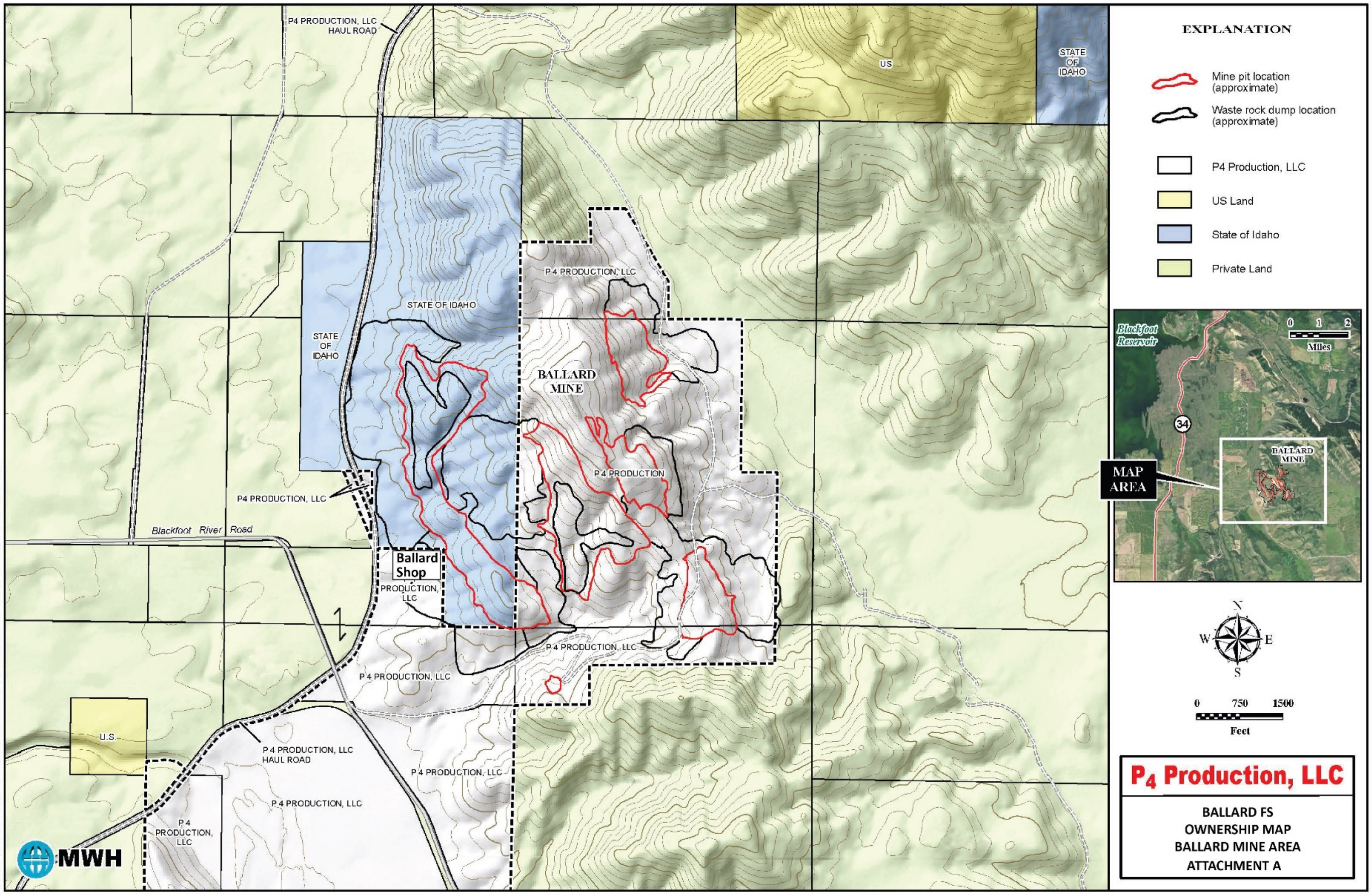
- MWH. 2015a. Sampling and Analysis Plan for Long-Term Monitoring of Surface Water and Groundwater at Ballard, Henry, and Enoch Valley Mines, Final.
- MWH. 2015b. On-Site and Background Areas Radiological and Soil Investigation Summary Report – P4's Ballard, Henry, and Enoch Valley Mines Remedial Investigation and Feasibility Study, Final.
- MWH. 2016a. Ballard Mine Feasibility Study Report – Memorandum 1 – Site Background and Screening Technologies, Final.
- MWH. 2016b. Ballard Mine Cover Material Exploration Work Plan, Final.
- MWH. 2017a. Ballard Mine Feasibility Study Report – Memorandum 2 – Screening, Detailed and Comparative Analysis of Assembled Remedial Alternatives, Final.
- MWH. 2017b. Ballard Mine Monitored Natural Attenuation Technical Memorandum. U.S. Environmental Protection Agency (EPA). 2009a. Administrative Settlement Agreement and Order on Consent/Consent Order for Performance of Remedial Investigation and Feasibility Study at the Enoch, Henry, and Ballard Mine Sites in Southeastern Idaho. United States Environmental Protection Agency, U.S. EPA Region 10, Idaho Department of Environmental Quality, United States Department of Agriculture, Forest Service Region 4, United States Department of the Interior, Bureau of Land Management, Shoshone-Bannock Tribes, in the Matter of Enoch Valley Mine, Henry Mine, Ballard Mine, P4 Production, L.L.C., Respondent. Effective Date of November 30, 2009.24

Useful Terms

Understanding environmental cleanup may be confusing for the average person. The following definitions of terms commonly used will assist your understanding of this document.

Term	Definition
Access Controls	Physical methods to discourage people from entering a site, including fencing and posting warning and informational signs.
Applicable and relevant or appropriate requirements (ARARs)	Any standard, requirement, criteria or limitation under federal environmental law or more stringent promulgated standard, requirement, criteria or limitation under State environmental or facility siting law that is legally "applicable to the hazardous substance (or pollutant or contaminant) concerned or is "relevant and appropriate" under the circumstances of the release.
Contaminants of Concern (COCs)	Contaminants, such as selenium and arsenic, that were found to exceed EPA's risk thresholds in the human health or ecological risk assessments.
Exposure	The amount of pollutant present in a given environment that represents a potential health threat to living organisms.
Exposure Pathway	How contaminants move from sources to humans and environmental receptors via paths such as dermal contact, ingestion, or inhalation.
Feasibility Study	A process to screen, develop, and evaluate various alternatives being considered for selection of a remedial action.
Institutional Controls (ICs)	Non-engineered instruments, such as administrative and legal controls, that help minimize the potential for human exposure to contamination and/or protect the integrity of the remedy.
Land Use Controls	LUCs typically consist of a combination of institutional controls (legal and administrative controls), access controls (physical controls) and community awareness activities to restrict access and use of contaminated areas and provide awareness of risks from exposure.
Mining-influenced Water	Water affected by mining activities and exposure to mineralized geologic material, that is potentially toxic to the environment, regardless of the pH.
National Priorities List (NPL)	EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term remedial action under Superfund. A site must be on the NPL to receive money from the Trust Fund for remedial action.
Operable Unit (OU)	A designation based on geography or other characteristics that defines a specific area of a site and enables the Superfund process to move forward in different areas at different times, speeding up the overall cleanup process at the Site.
Operation and Maintenance (O&M)	Activities conducted after a Superfund site action is completed to help sustain the effectiveness of the remedial action.
Periodic Costs	Costs that occur every few years on a scheduled basis, such as 5-year site reviews.
Present Value	The present worth (of a sum payable in the future) calculated by deducting interest that will accrue between the present and future date.
Remedial Action (RA)	The actual construction or implementation phase of a Superfund site cleanup that follows remedial design.
Record of Decision (ROD)	A public document that explains which cleanup alternative(s) will be used for the final remedy at the NPL site.
Remedial Investigation (RI)	An in-depth study designed to gather data needed to determine the nature and extent of contamination at a Superfund site; establish site cleanup criteria; identify preliminary alternatives for remedial action; and support technical and cost analyses of alternatives typically described in more detail in a co-associated Feasibility Study (FS).
Superfund	The program that funds and carries out EPA hazardous waste emergency and long-term removal and remedial activities. These activities include establishing the NPL, investigating sites for inclusion on the list, determining their priority and conducting and/or supervising cleanup and other remedial actions.
Watershed	A watershed is literally any sloping surface that sheds water, but the proper definition (Webster's) implies a topographic divide that sheds water into two or more drainage basins. Watershed is synonymous with drainage basin or catchment.

Attachments



P4 PRODUCTION, LLC
HAUL ROAD
US
STATE OF IDAHO
STATE OF IDAHO
STATE OF IDAHO
P4 PRODUCTION, LLC
BALLARD MINE
P4 PRODUCTION
P4 PRODUCTION, LLC
Blackfoot River Road
Ballard Shop
PRODUCTION, LLC
P4 PRODUCTION, LLC
P4 PRODUCTION, LLC
U.S.
P4 PRODUCTION, LLC
HAUL ROAD
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Waste rock dump location (approximate)
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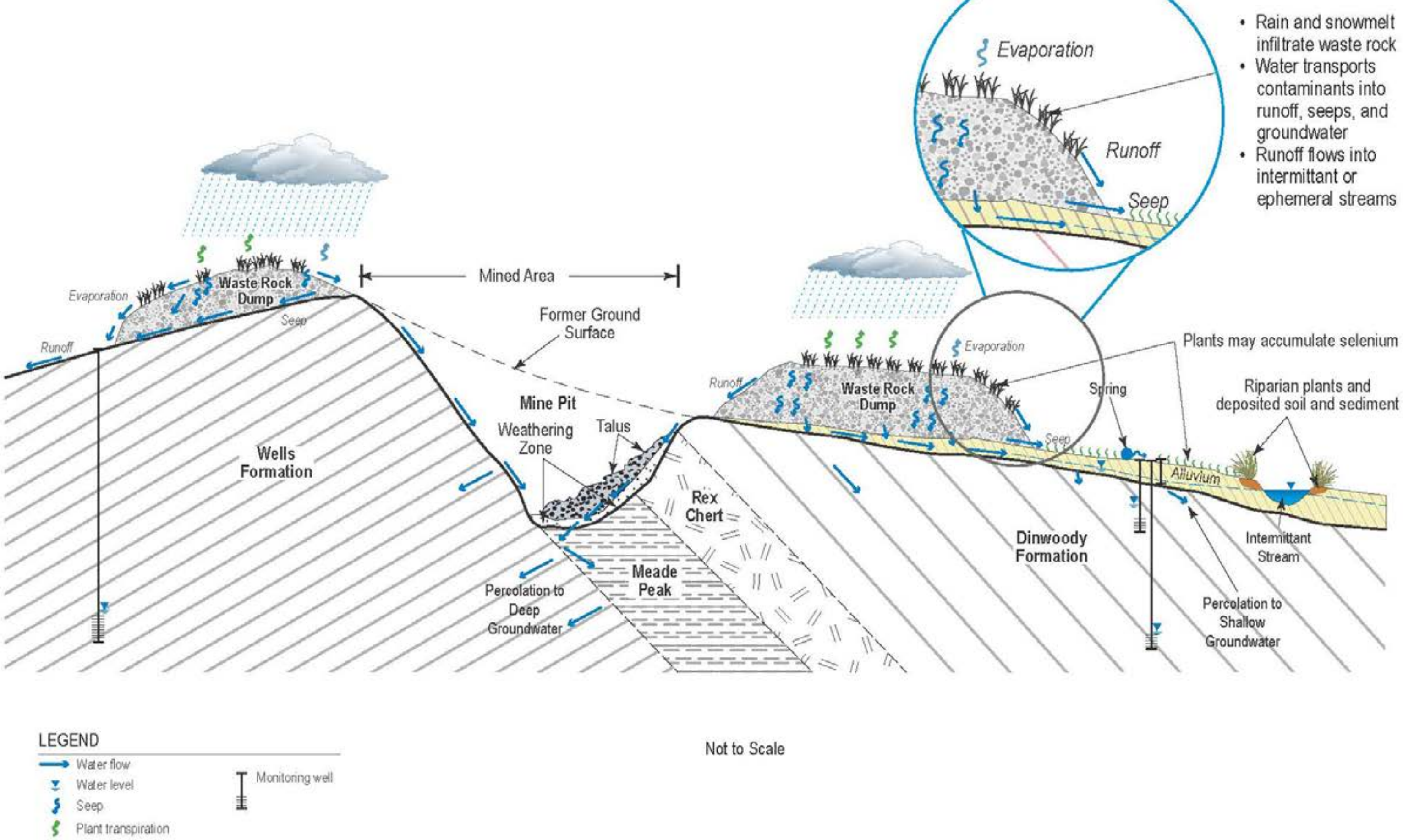
BALLARD FS
OWNERSHIP MAP
BALLARD MINE AREA
ATTACHMENT A



ATTACHMENT B
Conceptual Site Model
Cross Section *Ballard Mine*
Caribou County, Idaho