Preassessment Screen
For the Blue Ledge Mine Site

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EXECUTIVE SUMMARY

This Preliminary Assessment Screen (PAS) concerns the Blue Ledge Mine Site found within the Rogue River National Forest (National Forest) and addresses whether the criteria found in 43 C.F.R. § 11.23(e) have been met. Before proceeding with a natural resource damage assessment under regulations guiding trustees, the Forest Service must conduct a PAS and determine if the criteria are met.

This PAS documents that all criteria to proceed with a natural resource damage assessment have been met. It documents that the Forest Service has a reasonable probability of making a successful natural resource damage claim for injuries to National Forest resources resulting from releases of hazardous substances from the Blue Ledge Mine.

The data and analysis presented in this PAS demonstrates that all the criteria for a natural resource damage assessment under waste the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) have been met. In particular:

1) A release of hazardous substances from the Blue Ledge Mine Site has occurred;
2) Natural resources under the trusteeship of the Forest Service and/or other natural resource trustees have been affected; e.g., water resources and biologic resources (fish), or are likely to have been affected by releases from the Blue Ledge Mine Site;
3) The quantity and concentration of released hazardous substance is sufficient to cause injury to natural resources;
4) Data sufficient to pursue an assessment are readily available or likely to be obtained at a reasonable cost; and response actions, if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.

The Blue Ledge Mine is located on privately owned land within the National Forest, three miles south of the Oregon-California border. The mine is situated near the headwaters of Joe Creek, a tributary stream within the Upper Applegate Watershed. The mine is one of the largest mining operations ever undertaken in the southwestern Oregon area. Over two miles of underground excavations were developed to mine massive sulfide deposits rich in copper, zinc, gold and silver. Large-scale mining ceased in the 1930s and left at approximately 60,000 tons of exposed sulfide-rich waste rock. The remaining waste piles and workings at the Blue Ledge Mine Site have released and continue to release hazardous substances listed under CERLCA.

Water samples taken in 2000 and 2001 by the Forest Service document releases of hazardous substances from the Blue Ledge Mine in levels injurious to human health and aquatic resources. Various analytes were detected in these samples at concentrations that exceed federal and state primary and secondary drinking water standards. Exceedances of primary drinking water standards were detected for cadmium, copper and acidity while additional exceedances of secondary drinking water standards were detected for copper, iron and zinc. There have also been numerous exceedances of aquatic life criteria (ALCs), which are measures of the maximum concentrations to which aquatic organisms can be exposed without deleterious effects, in Joe Creek and Elliott Creek. The concentrations detected in these samples are often many times that of the standard.

A review of the literature shows that the contaminants released from the Blue Ledge Mine are toxic to aquatic resources, such as fish and macroinvertebrates. Metal concentrations detected in Joe and Elliott Creeks are much higher than those found to result in adverse effects and high mortality rates in rainbow trout and other fish. Survey data have confirmed that there are no fish in Joe Creek. In addition, survey data reveals that the amphibian and macroinvertebrate populations in Joe Creek have been adversely impacted due to AMD releases from the Blue Ledge Mine. Groundwater resources are likely to be impacted.

The Forest Service has preliminarily identified the areas in and around 1) Joe Creek, 2) Elliott Creek downstream of Joe Creek, 3) the Middle Fork of the Applegate River downstream of Elliott Creek, and 4) the Applegate Reservoir as areas where exposures to hazardous substances released from the Blue Ledge Mine can occur. The Forest Service reached this conclusion for the following reasons. First, it is likely that waste fines from the Blue Ledge Mine are transported via Joe Creek to Elliott Creek and to the Applegate Reservoir. Second, analyses of water samples taken in April 2001 in Elliott Creek upstream and downstream of the confluence with Joe Creek document that dissolved metals from the mine have been transported to Elliott Creek. Third, to the extent bioaccumulation of hazardous substances has occurred, natural resources that live in areas removed from these water-bodies could be affected.

Because hazardous substances have been released in all years since the mine's development and operation, potentially responsible parties (PRPs), absent a defense or exclusion from liability, include the current owners and operators of the site as well as all prior owners and operators. The Blue Ledge Mine has had at least 14 owners/lessees/operators throughout its existence. These PRPs include major corporations, such as the American Smelting and Refining Company (ASARCO). None of the damages at the site is excluded from liability under CERCLA or the Clean Water Act (CWA). All of the possible exclusions have been analyzed and found not to be applicable at the Blue Ledge Mine Site.

Pursuant to Section 107(f) of CERCLA, as amended, 42 U.S.C.§ 9607(f) and other applicable federal, state, and tribal laws, designated federal, state, and tribal officials may act on behalf of the public as trustees for natural resources under their management authority to recover damages for injuries to such resources resulting from releases of hazardous substances. Designated natural resource trustees may pursue claims under CERCLA against parties liable under Section 107 of CERCLA, 42 U.S.C. § 9607. The Department of Agriculture, through the U.S. Forest Service, has been designated as a federal trustee for natural resources located on, over, and under national forest lands with authority to pursue natural resource damage claims under CERCLA.

1.0 INTRODUCTION

Pursuant to Section 107(f) of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended, 42 U.S.C.§ 9607(f) and other applicable federal, state, and tribal laws, designated federal, state, and tribal officials may act on behalf of the public as trustees for natural resources under their management authority to recover damages for injuries to such resources resulting from releases of hazardous substances. Designated natural resource trustees may pursue claims under CERCLA against parties liable under Section 107 of CERCLA, 42 U.S.C. § 9607, for damages for injury to, destruction of, or loss of natural resources under their trusteeship resulting from a release of hazardous substances. Sums recovered must be used to restore, replace, or acquire the equivalent of resources injured, destroyed, or lost. Parties liable for natural resource damages under CERCLA include current owner and operators of land/facilities from which there is a release of hazardous substances and prior owners and operators of land/facilities at times when hazardous substances were discharged or disposed into the environment.

Regulations have been promulgated under CERCLA, 43 C.F.R. Part 11, to guide trustees in the assessment of natural resource damages resulting from releases of hazardous substances. The regulations are optional; however, trustees following the regulations receive the benefit of a rebuttable presumption in court for "any determination or assessment of damages."[1] Before beginning a natural resource damage assessment trustees following the regulations must first undertake a preliminary assessment screen (PAS). The purpose of a PAS is to review available information rapidly and determine whether or not there is a reasonable probability of making a successful natural resource damage claim. Trustees must determine that a site meets the criteria set forth at 43 C.F.R. § 11.23(e) before proceeding with an assessment.

The Department of Agriculture, through the U.S. Forest Service (Forest Service), has been designated as a federal trustee for natural resources located on, over, and under national forest lands with authority to pursue natural resource damage claims under CERCLA.[2] Consistent with its trustee responsibilities, the Forest Service commissioned this PAS to determine whether or not the Blue Ledge Mine has released hazardous substances into the environment and whether or not such releases are potentially causing injuries to the natural resources of the Rogue River National Forest. More specifically, this PAS addresses whether the regulatory criteria found in 43 C.F.R. § 11.23(e) for a natural resource damage assessment have been met; in particular, whether:

1) A release of hazardous substances from the Blue Ledge Mine Site has occurred,
2) Natural resources under the trusteeship of the Forest Service and/or other natural resource trustees have been or are likely to have been affected by releases from the Blue Ledge Mine Site,
3) The quantity and concentration of released hazardous substance is sufficient to cause injury to natural resources,

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[1] 42 U.S.C. § 9607(f)(2)(c).

[2] See Exec. Order No. 12,580, 3 C.F.R. 193 (1987), and Subpart G of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), 40 C.F.R. § 300.600.

4) Data sufficient to pursue an assessment are readily available or likely to be obtained at a reasonable cost, and
5) Response actions, if any, carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.

Section 2 of this report presents summary information regarding the location and characteristics of the Blue Ledge Mine Site and the resources in the area under the trusteeship of the Forest Service. Section 3 addresses site history and information regarding the release of hazardous substances. Section 4 presents a preliminary identification of resources potentially at risk and includes a discussion of exposure pathways, exposed areas, and resources potentially at risk. Section 5 identifies potentially responsible parties for the Blue Ledge Mine Site. Section 6 applies required pre-assessment screen criteria found in 43 C.F.R. § 11.23(e). As explained in Section 6, the Forest Service has concluded that all the regulatory predicates for a natural resource damage assessment have been met.

2.0 THE BLUE LEDGE MINE AND ITS ENVIRONS

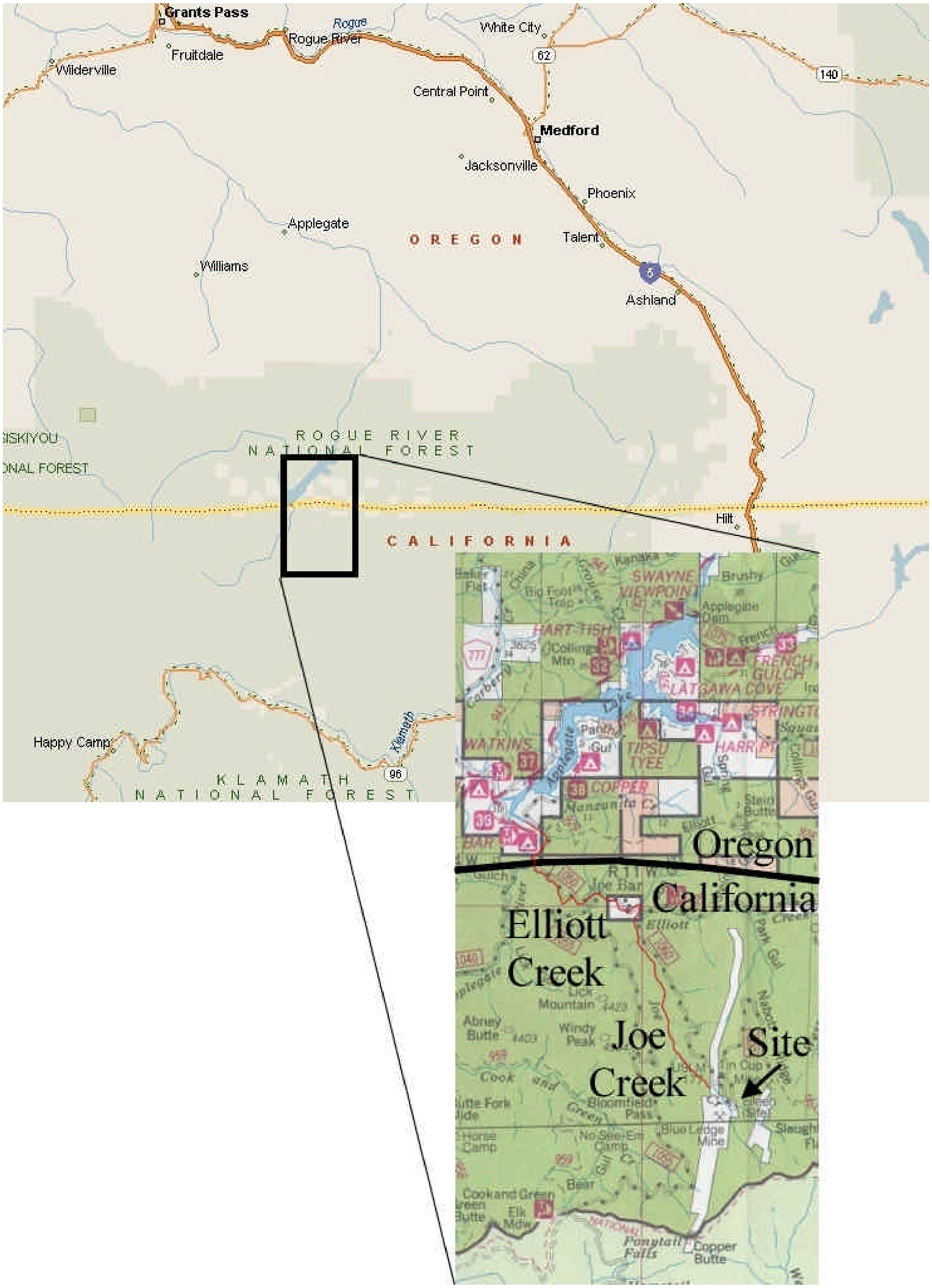
2.1 Location and Site Characteristics

The Blue Ledge Mine is located on privately patented owned land within the Rogue River National Forest (National Forest), three miles south of the California-Oregon border. Jacksonville, Oregon, the nearest town, lies 33 miles to the northeast (See Map 1). The site is approximately 40 miles south of Medford, Oregon.

The Blue Ledge Mine was one of the largest mining operations ever undertaken in the southwestern Oregon area (Kramer 1999). Over two miles of underground excavations and connections were developed to mine massive sulfide deposits rich in copper, zinc, gold and silver (Hundhausen 1947). Historically, the economic value of the mine lay in extraction of copper and zinc.

The Blue Ledge Mine is situated within the Siskiyou Mountain range. The mine is on a north slope, near a summit in the range, about 4,800 feet above sea level (Hundhausen 1947). The terrain is rugged, precipitous in places. Runoff is rapid and the potential for erosion is high. The mine workings penetrate steep slopes and rock outcroppings and honeycomb the ground beneath these features. Waste rock has been dumped on the steep slopes; a large waste rock disposal area can be viewed easily from FS Road 1060.

Photo 1: Blue Ledge Mine And Waste Area Seen From FS Road 1060


Grants Pass
Rogue
Rogue River
White City
62
140
Wilderville
Fruitdale
Central Point
Medford
Jacksonville
Phoenix
Applegate
OREGON
Talent
5
Williams
Ashland
SISKIYOU
NAL FOREST
ROGUE RIVER
NATIONAL FOREST
Hilt
CALIFORNIA
Happy Camp
Klamath
96
KLAMATH
NATIONAL FOREST
Oregon
California
Elliott
Creek
Joe
Creek
Site
Blue Ledge
Mine
Copper
Butte

Map 1

Based on visual observations, it appears that material less than one centimeter in diameter comprises over 50% of the waste (see Photo 5, p. 13). Waste in the main waste pile at a deep spot, at the bottom of the mountainside, is estimated to be over 30 feet deep. A stream cuts down the mountainside through the waste pile. Other waste areas visible on aerial photographs and areas suggested from historical accounts cannot be seen from the road below.

Photo 2: Blue Ledge Mine Site, circa 1913
Southern Oregon Historical Society, #2440

Historic photos indicate there was extensive logging at the Blue Ledge Mine Site to supply timber for mining, building and heating (see Photo 2). Since then, additional logging has been followed by re-growth and the establishment of early-successional forests over some portions of the site.

2.2 Geology

The geologic region in which the Blue Ledge Mine is located comprises predominantly pre-Tertiary rocks that are set apart from the Tertiary rocks that make up the remainder of southern Oregon (Franklin and Dyrness 1988). The pre-Tertiary rocks in this area are the oldest in Oregon. The Blue Ledge Mine is located within the Condrey Mountain Schist in the east-central part of the Klamath Mountains geomorphic province, which comprises a series of north-south trending sedimentary and volcanic rocks containing massive sulfide deposits up to five million tons. The Condrey Mountain schist is a highly faulted and fractured, approximately 250-square-mile area of sedimentary and volcanic rocks thrust together with older rocks. Rocks in this belt have been correlated with other similar formations that host massive sulfide deposits at the Almeda and Silver Butte mines located in the region (Mattinen 1990).

Locally, rocks underlying the Blue Ledge Mine are predominantly north-south striking, steeply west dipping, metamorphosed sedimentary and volcanic rocks, showing strong deformation. Most of the ore zone of the mine is localized within schist (sericite and quartz). Massive sulfide mineralization underlies the mine, with the main ore body consisting of lenses, stringers, and bands of primary copper-zinc sulfides. Sulfides, in approximate order of abundance, are pyrrhotite, pyrite, chalcopyrite, and sphalerite. Gold and silver are found with the copper minerals (Hundhausen 1947).

Soils in the area are from weathered metamorphic schist material (Franklin and Dyrness 1988). Soils are generally shallow, gravelly clay loam soils having bedrock within one meter of the surface and the bedrock is frequently exposed.

2.3 Climate and Hydrology

The mean average monthly temperature ranges from 33.2°F in January to 64.9°F in July. At 4,800 feet above sea level, the Blue Ledge Mine is located in a transient snow zone where periods of rain-on-snow events can occur, which creates a high risk of mass wasting and surface erosion (USFS 1995). Snow slides are frequent in gullies and on steep slopes like that found at the mine. The average annual precipitation in the vicinity of the mine has been reported as 138 inches of snow and 33 inches of rain (Hundhausen 1947). However, rainfall at Blue Ledge Mine is likely to be over 40 inches per year due to its location and elevation (USFS 1995, Rainfall Isopleths). Over 86% of the annual runoff at the mine occurs from December through June (USFS 1995). See Chart 1 below.

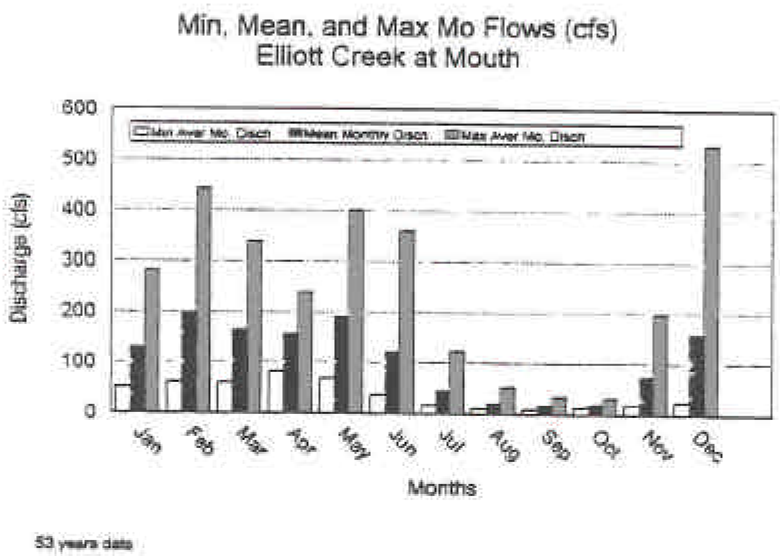


Chart 1

The Blue Ledge Mine is situated near the headwaters of Joe Creek, a stream within the Upper Applegate Watershed of the Rogue River National Forest. Joe Creek begins in the National Forest and flows across private land where the Blue Ledge Mine sits. The mine is approximately 800 vertical feet above and 1200 horizontal feet away from Joe Creek.

At the mine, a tributary cuts down the steep mountainside, flowing directly through many feet of waste rock to meet Joe Creek. After the confluence with this tributary, Joe Creek returns to the National Forest and flows north to Elliott Creek. Elliott Creek is about 3.4 miles downstream of the mine. About a mile and half after the confluence with Joe Creek, Elliott Creek joins the Applegate River, which feeds the reservoir known as Applegate Lake. The lake is approximately five miles long and the Applegate Reservoir dam is about eight miles downstream of the mine.

Given that most of the precipitation occurs in Joe Creek and the Upper Applegate Watershed during winter months, rain-on-snow events are not uncommon and are the primary cause of flooding in the Upper Applegate watershed. Pulses of runoff occurring at these times create a high risk for mass wasting and surface erosion (USFS 1995). In Joe Creek, fines from waste rock piles and precipitates from mine drainage may be entrained during runoff and carried into the creek and downstream. At higher flow velocities and volumes, fine particles of waste rock may be carried for miles before the carrying capacity of the water is reduced sufficiently so that the sediment load is deposited. Thus, as a result of individual and successive high flow events, there is the potential for waste rock fines to be carried through Joe Creek to Elliott Creek and the Upper Applegate River as well as to the Applegate Reservoir.

2.4 Natural Resources of the Rogue River National Forest Near the Mine

The Blue Ledge Mine is found within the Squaw/Elliott/Lake Watershed Analysis Area of the Rogue River National Forest (Study Area). Caves (including abandoned mines) in the study area provide nesting and roosting habitat for up to 12 bat species (USFS 1995). Other species in the study area include 12 amphibian species, 19 reptile species, 100 bird species, and more than 60 mammal species. Black bear and blacktail deer forage in the area. The northern goshawk has been identified as an U.S. Fish and Wildlife (FWS) candidate species, the Siskiyou Mountain salamander is an endemic species (USFS sensitive species, California-threatened species), and the northern bald eagle and the northern spotted owl are federally listed as threatened species (USFS 1995).

Above Applegate Lake, resident rainbow and cutthroat trout populations are common and pacific lamprey and reticulate sculpin may also be present in the watershed. Elliott Creek contains approximately 20.4 miles of resident rainbow and cutthroat trout fish habitat. Joe Creek itself contains no fish. Historically, fall Chinook, Coho salmon, pacific lamprey, and steelhead migrated up the Applegate River to the watershed holding Joe and Elliott Creeks. However, since the late 1970s the Applegate Dam has been a barrier to such migrations and these anadromous fish are no longer found upstream of the dam (USFS 1995).

Mesic forests typify the area of the Blue Ledge Mine and are dominated by *Pseudotsuga menziessii* (Douglas fir), *Pinus ponderosa* (ponderosa pine), and *Libocedrus decurrens* (incense-cedar) over a lower canopy of *Quercus garryana* (Oregon white oak) (Hunduasen 1947 and USFS 1995). Other species reported near the Blue Ledge Mine Site include sugar pine, yellow pine, and lodge-pole pine (USFS 1995).

3.0 SITE HISTORY AND INFORMATION REGARDING THE RELEASE OF HAZARDOUS SUBSTANCES AT THE BLUE LEDGE MINE SITE

3.1 History, Uses and Relevant Operations at the Site

The Blue Ledge Mine was discovered in 1898 by three miners who were panning on Joe Creek. Active mining at Blue Ledge occurred intermittently over the next several years. Work to develop the mine occurred between 1904 and 1909. From mid-1909 to late-1916, the mine was inactive. The high prices for metals around the time of World War I caused renewed activity at the mine. From 1917 to 1920, over 8,000 tons of ore were hauled away from the mine. After this the mine entered another period of inactivity from 1920 to 1929. In early 1930, the mine became active for another brief period. In 1930, more than 2,500 tons of ore were shipped from the site to be smelted (Hundhausen 1947). Despite interest in the mine, no large-scale mining activity has occurred since the 1930s. Exploratory drilling, sampling, and mapping, however, have been undertaken periodically.

During the mine development and ore extraction, more than two miles of underground excavations and connections were blasted and hewn out of the rock. A substantial amount of waste rock was generated as workings were dug and ore was removed. A mining car that ran on a track carried ore and waste rock from the mine's interior to a mine adit atop the Blue Ledge and the face of the slope. Mine workers would "push [the muck] out the mouth of the tunnel and the waste rock they dumped over" (Dymond, Southern Oregon Historical Society). Timber dikes were placed on the mountainside to prevent waste rock from avalanching to the mining camp (O'Hara, 1964).

Information is not entirely clear about the exact nature and location of the ore separation. A mineworker reports that the "separated ore" from the mine tunnels was trammed down via overhead cable to a location close to Joe Creek (Hutchinson 1998 and Dymond, Southern Oregon Historical Society) (see Photo 3). Some mine workings are still seen at the top of the mountainside along with partial lengths of cable.

Photo 3: Blue Ledge Mine Building, circa 1915
Southern Oregon Historical Society, #6839

Photos and interviews suggest that at the bottom of the mountainside near Joe Creek there was an assay building for processing and perhaps crushing ore (Dymond, Southern Historical Society). This building may have been on the north side of Joe Creek. Photos dating from approximately 1915 show a building that logically fits this description. This building may have housed a stamp mill (see Photo 4). Stamp mills were used during this period to crush rocks with large metal cylinders. Some stamp mills from the period used water in beneficiation of the ore whereas others relied on dry screening methods (Krom 1876). Regardless of how the crushing or sorting occurred, it is well documented that ore was transported from the Blue Ledge Mine to a smelter in Tacoma (Hundhausen 1947; Dymond, Southern Historical Society).

The photo of the building at the bottom of the mountain shows what appears to be waste surrounding the building and possibly forming the foundation for the wagon road that leads down the ravine (see Photo 4). Prior to 1920, unprocessed ore was stored in dumps (O'Hara 1985), some of which was processed in 1930 by Reddy and Hughes (Hundhausen 1947).

Tons of waste littering the steep slope of the Blue Ledge are easily visible today from FS Road 1060. Other waste is still on slopes not visible from the road. Based on an understanding of the site history, waste piles may exist under vegetation near Joe Creek on the north or south side of the Creek. Waste is also stored in the mine itself (Hundhausen 1947).

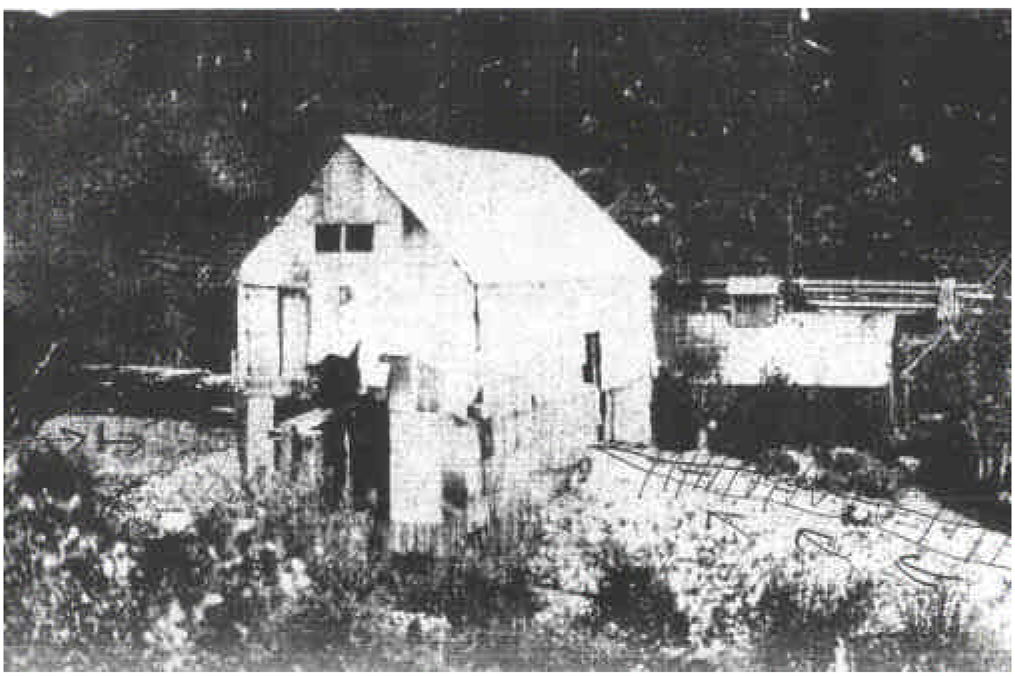


Photo 4: Blue Ledge Mine Building, circa 1915
Southern Oregon Historical Society, #6839b

3.2 Information Regarding the Type, Quantity, Duration, and Frequency of Releases of Hazardous Substances

3.2.1 Acid Mine and Rock Drainage – A Source of Hazardous Substances

An understanding of the geology, geo-chemistry, and site characteristics of the Blue Ledge Mine leads to the conclusion that sulfuric acid and metals including cadmium, copper, and zinc, have been and are being released at the site. Sulfuric acid, copper, cadmium, and zinc are CERCLA listed hazardous substances pursuant to 40 C.F.R. § 302.4.

Mines exploiting mineralized sulfide deposits, and their associated waste rock, are widely known to release sulfuric acid and dissolved metals by a process called acid mine drainage (AMD) or acid rock drainage (ARD).[3] The sulfide deposits that sparked the economic development of the Blue Ledge Mine unfortunately, with development, provide a continuing source of AMD that can be harmful to natural resources. AMD at the Blue Ledge Mine is continually formed by a weathering process that oxidizes sulfur-bearing minerals to sulfate and acidity. The AMD process is further expedited by oxidation of the reduced minerals by microbes (Schrenk et al. 1998). The production of acidity at Blue Ledge, which includes sulfuric acid, causes metals to leach from surrounding waste rock as water percolates through the scattered waste piles. The small particle size of the waste rock at Blue Ledge presents more favorable conditions for the production of AMD than an equivalent tonnage of waste rock with a smaller total surface area such as would be the case if the waste pile were comprised only of large rocks. As demonstrated by sampling data discussed in the next section, the water percolating through the waste rock at the Blue Ledge Mine carries dissolved cadmium, copper, zinc, and other metals downslope and downstream into Joe Creek creating an environment toxic to aquatic life.

3.2.2 Sources and Nature of Releases of AMD

As explained in greater detail in this subsection a minimum of 55,000 – 60,000 tons of waste rock remains at the Blue Ledge Mine Site. The characteristics of the Blue Ledge Mine and its waste make it highly productive in terms of creation of AMD and releases of CERCLA listed hazardous substances – certain metals and sulfuric acid. Releases of hazardous substances began with mine development and have occurred in every year since. Extensive iron staining and ferricrete[4], indicative of AMD, has been observed in a tributary flowing from the Blue Ledge Mine site and in Joe Creek downstream of the confluence with this tributary. Releases from the site also have produced exceedances of primary and secondary drinking water standards in Joe Creek, a navigable water of the United States. The AMD has resulted in metals concentrations in Joe Creek downstream of the mine in excess of freshwater aquatic life criteria (ALCs) promulgated by EPA under the Clean Water Act as a benchmark for the protection of aquatic

[3] AMD is sometimes reserved to refer to the leachate coming from the rock in a mine exposed by mining and drilling. ARD, on the other hand, is often used to refer only to the leachate coming from waste rock. This PAS uses AMD to refer to both of these processes – the leachate from mine workings and the leachate from waste rock.

[4] Ferricrete is a conglomerate consisting of sand and gravel cemented into a hard mass by iron oxide derived from oxidation of a percolating solution of iron salts.

communities. Exceedances of ALCs will be discussed more fully in Section 4.0, however, these data are clear evidence that the AMD from the Blue Ledge Mine is of sufficient quantity to produce metals concentrations in Joe Creek toxic to aquatic life. More specifically, information and data that help form the basis of these conclusions are as follows.

Mine Workings

During mine development and ore extraction, more than two miles of excavations and connections (drifts, adits, winzes, and raises) were created (Hundhausen 1947). As a result of these activities, substantial waste rock also was produced. There are at least six adits with approximately 8,240 linear feet of workings where natural ventilation throughout the mine was reported as good, suggesting the oxidation of exposed minerals in the mine workings could be extensive (Hundhausen 1947). Tons of waste rock remain in the mine as relatively small rocks. (Hundhausen 1947). Waste rock is also likely to be relatively well aerated. Thus, the mine workings and waste rock present favorable conditions for creation of substantial AMD.

Waste Rock

As the historic accounts explain and current site conditions confirm, Blue Ledge waste rock, called "muck" by the miners, was dumped on steep slopes adjacent to mine portals (Dymond, Southern Historical Society). From the miners' perspective, these steep mountain slopes offered a desirable disposal site, as waste would be carried down the mountainside by gravity, slides, avalanches, and runoff. Waste rock can be seen from FS Road 1060.

Photo 5: Fines on the steep slopes above FS Road 1060
Photo by Kathleen Page, Ph.D., Southern Oregon University

Based on a review of the tons of ore shipped from the site for smelting and the miles of mine workings, a minimum of 55,000-60,000 tons of waste rock has been left at the site.[5] Estimates based on aerial photographs indicate that waste

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[5] During the period of 1917 to 1930, the Blue Ledge Mine shipped over 11,000 tons of ore away from the site to be smelted (Hundhausen, 1947). At the Blue Ledge Mine the Bureau of Mines (Hundhausen) estimated that the ratio of material broken at the site to ore shipped off-site was 6 to 1, although Hundhausen indicated that the ratio was probably higher in some areas (Hundhausen 1947). If the conservative estimate of 6 to 1 is used, then waste rock generated at this mine exceeded 55,000 tons during the period of 1917 to 1930. This estimate can be verified by using estimates of the length and cross section of tunnels dug at the mine. Hundhausen determined that approximately 13,310 feet of tunnels with an average cross section of 6 feet by 8 feet were dug at the site. Another source estimated that over 15,000 lineal feet of excavation was conducted at the site (Mining in Southwestern OR: A Historic Context Statement by George Kramer, 1999). Using the lower numbers from BOM and the specific gravity reported after BOM's analysis, the minimum waste rock generated at the site can be estimated at just over 60,000 tons. This number is similar to that calculated using just the delivered ore and the ratio of delivered ore to disturbed material.

rock at the Blue Ledge Mine covers about 25 to 34 acres. The shallowest waste deposits are high up the mountainside and the deepest deposits are toward the middle and bottom of the mountainside on a tributary of Joe Creek, behind a log "dam." The waste entirely covers this tributary feeding Joe Creek. The bottom of the main waste disposal area is only a couple of hundred yards from Joe Creek.

Particles the size of coarse sand predominate the waste in this large disposal area seen from FS Road 1060. Small stones and rocks discarded as waste by the miners are mixed among coarse sand-sized particles. Waste ranges from 1' to 30' deep on the steep slope. See Photo 5, Page 13.

Samples Document Substantial Releases of Hazardous Substances from the Mine

Recent water sampling undertaken by the Forest Service confirms the conclusion that sulfuric acid and metals listed as hazardous substances are being released by the Blue Ledge Mine Site. The data show exceedances of primary and secondary drinking water standards and ALCs, criteria that offer benchmarks for the protection of aquatic life in surface waters of California.

The Forest Service collected samples at sites displayed on Map 2, Page 16. Sampling rounds occurred in September 2000, April 2001 and August 2001. Water samples were not collected at all sites during each round; some locations were dry. Samples were analyzed for pH, metals, dissolved oxygen, temperature, conductivity, hardness, sulfate, and total alkalinity. Of the 12 sample locations, there were five stations on the main stem of Joe Creek. One Joe Creek sample location was upstream of the mine (and waste rock) and four sample locations were downstream. Beginning at the station upstream of the mine and waste and heading downstream to Elliott, the Joe Creek sample stations are as follows:

- **Joe Creek 5 (JC5) –** upstream of the mine and its waste.
- **Joe Creek 4 (JC4) –** near confluence of a tributary downstream of the mine and which flows through the main waste rock disposal area.
- **Joe Creek 3 (JC3) –** approximately 0.75 miles downstream of the mine and waste rock.
- **Joe Creek 2 (JC2) –** approximately 2.25 miles downstream of the mine and waste rock.
- **Joe Creek 1 (JC1**) – Joe Creek near its mouth, where it meets Elliott Creek, approximately 3.4 miles downstream of the mine and waste rock.
- **Joe Creek 6 (JC6) –** downstream of mine waste on a headwater branch of Joe Creek, whose confluence with Joe Creek is downstream of JC5.

Samples were taken at two springs along Joe Creek. These locations are as follows:

- **Joe Creek Spring 1 (JCS1) –** spring crossing the spur road near JC5.
- **Joe Creek Spring 2 (JCS2) –** spring entering Joe Creek form the north bank near JC4.

JCS2 may be in an area where waste rock historically was dumped and/or used to make the road used for the transportation of ore from the mine.

Blue Ledge 1 (BL1) is located on a side stream that runs through the main waste pile visible from FS Road 1060 and enters Joe Creek 800 vertical feet from the mine. The sample site is located approximately 200 yards from a timber dike. It appears that over 30 feet of waste has accumulated behind this dike, which sits at the bottom of the mountain slope on which the mine sits. Extensive iron staining and formation of ferricrete, indicative of AMD, was seen in this tributary and in Joe Creek at and downstream of its confluence with this Blue Ledge tributary.

There are two sample locations on Elliott Creek.

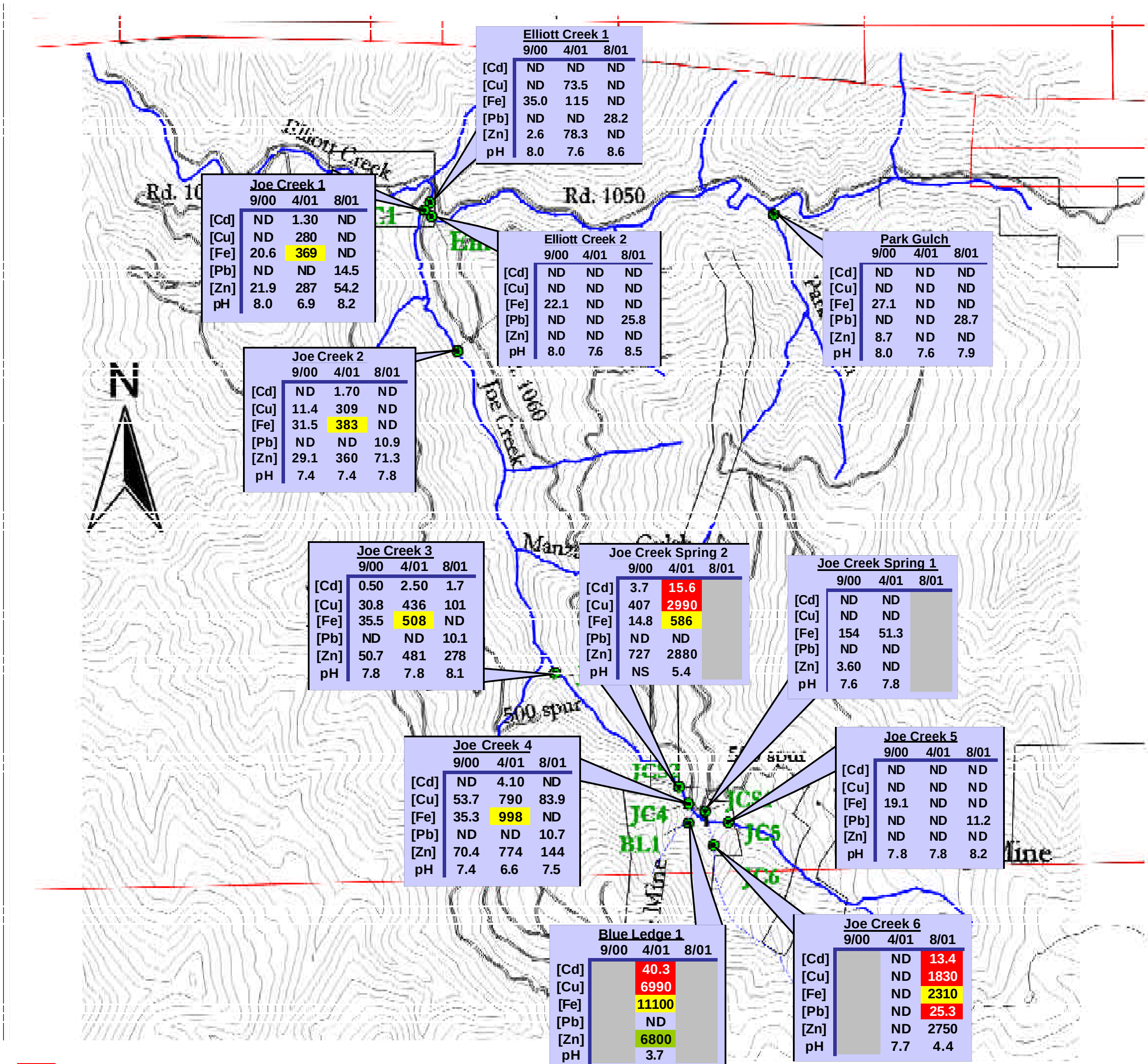
- **Elliott Creek 1 (EC1) –** just upstream of the confluence with Joe Creek.
- **Elliott Creek 2 (EC2**) **–** just downstream of the confluence with Joe Creek.

One sample site, **PG1,** was located on Park Gulch near its mouth.

Map 2 (see next page) displays the data for pH and selected metals in samples collected during 2000 and 2001. In April of 2001, BL1, the tributary of Joe Creek that flows through the main waste rock disposal area, was highly acidic with a pH of 3.7. No samples were taken during the summer, as the tributary was dry. In August 2001, a month characterized by low flows, Joe Creek 6, situated downstream of a smaller waste rock area associated with the mine, recorded a pH of 4.4. All other sample locations except JCS2 show pHs between 7.8 and 8.0. Based on historical information, JCS2 is suspected to be in close proximity to buried waste rock. These data provide evidence that sulfuric acid, a hazardous substance, is being released from the Blue Ledge Mine. Cadmium, copper, iron, and zinc concentrations found in samples from the main stem of Joe Creek are displayed on Charts 2 to 4. The data show striking differences in concentrations of metals between samples taken upstream and those taken downstream of the mine and its waste.

JC5, upstream of the mine, showed non-detects. Conversely, the sample locations downstream of the mine have high concentrations of cadmium, copper, iron, and zinc; moreover, there is a clear gradient in concentrations moving away from the mine. The highest concentrations reported for all four metals are found in the sample taken at JC4, the location closest to the mine. As Charts 2 and 3 show, the concentrations of all four metals decrease with increasing distance from the mine. During the same sample round, there were very high concentrations of cadmium, copper, iron, and zinc in the sample taken at BL1, the tributary of Joe Creek passing through the main waste rock disposal area seen from FS Road 1060. In addition, there were non-detects at Park Gulch, a reference site, for the same metals (see Data Display, Map 2). Thus, the data present a clear gradient that points to the Blue Ledge Mine as the source of the releases of cadmium, copper, iron, and zinc. As noted above, cadmium, copper, and zinc are listed hazardous substances. Thus, the metals data provide evidence of releases of hazardous substances from the Blue Ledge Mine.

Water Samples, 2000 & 2001



= Metal concentrations have exceeded federal and state Maximum Contaminant Levels*

= Iron concentration has exceeded its federal secondary drinking water standard*

= Zinc concentration has exceeded its federal Maximum Contaminant Level Goal

All metal concentrations expressed in parts per billion (ppb)

Streams marked with dotted lines become dry in summer months

***Federal and State Drinking Water Standards (ppb)**

Metal	Federal MCL	State MCL	Secondary Standard	Federal MCLG
Cd	5	5	N/A	5
Cu	1300	1000	1000	1300
Fe	N/A	N/A	300	N/A
Pb	15	15	N/A	0
Zn	N/A	N/A	5000	N/A

Map 2

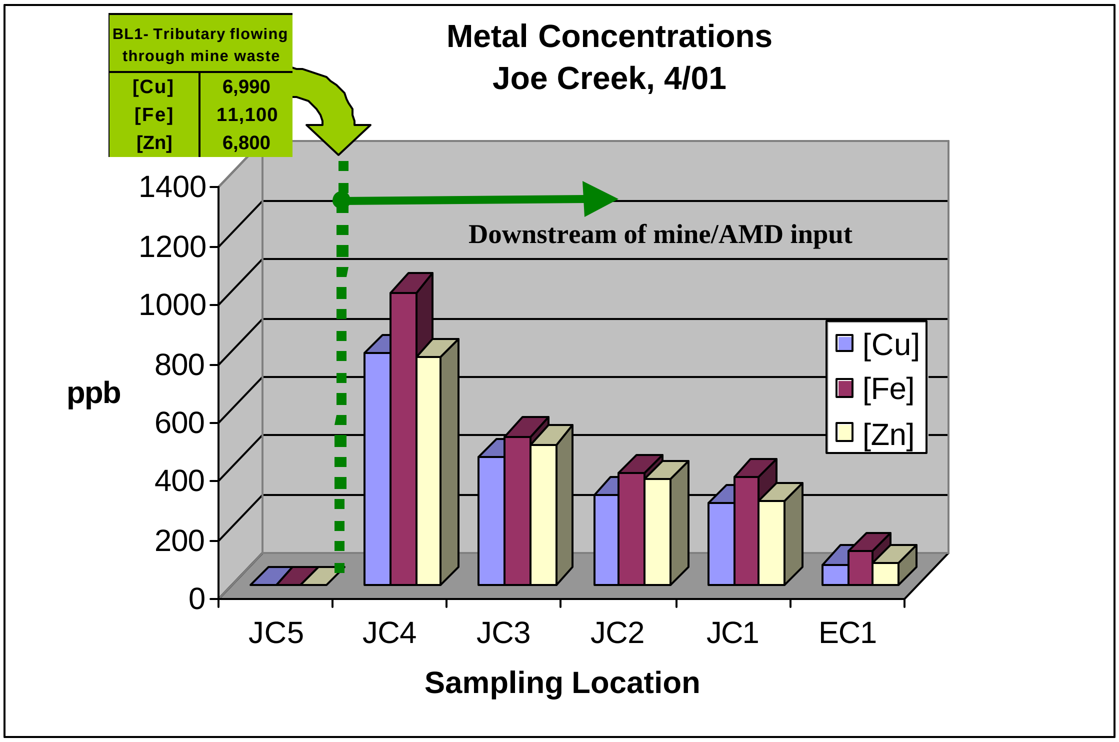


Chart 2

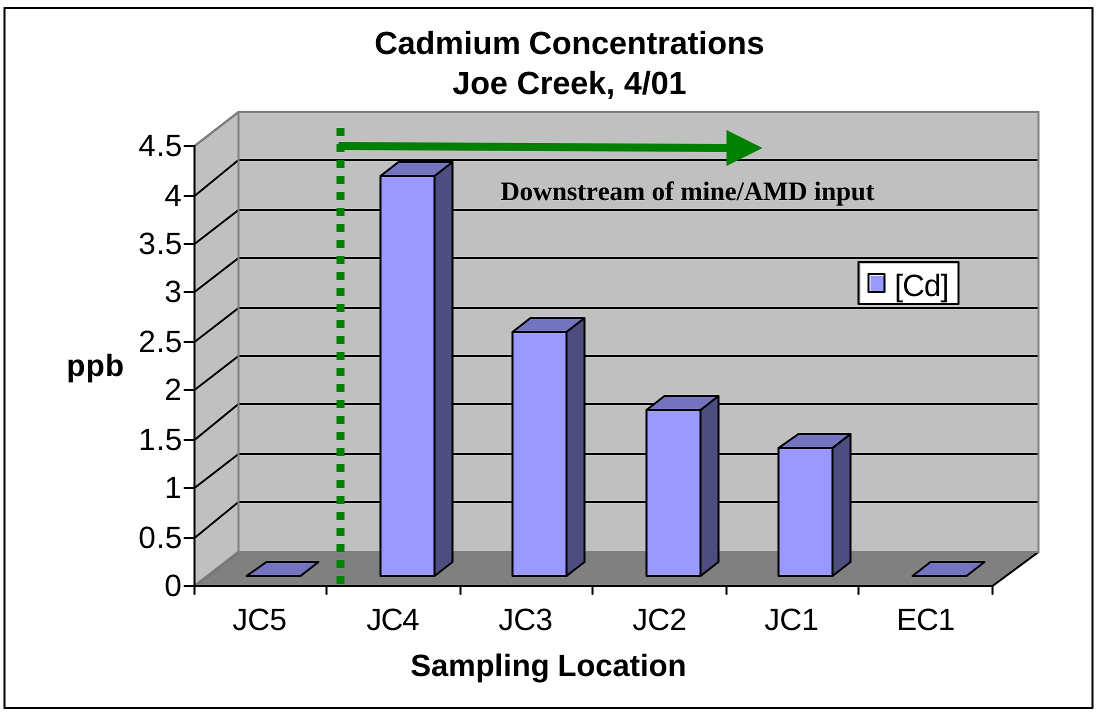


Chart 3

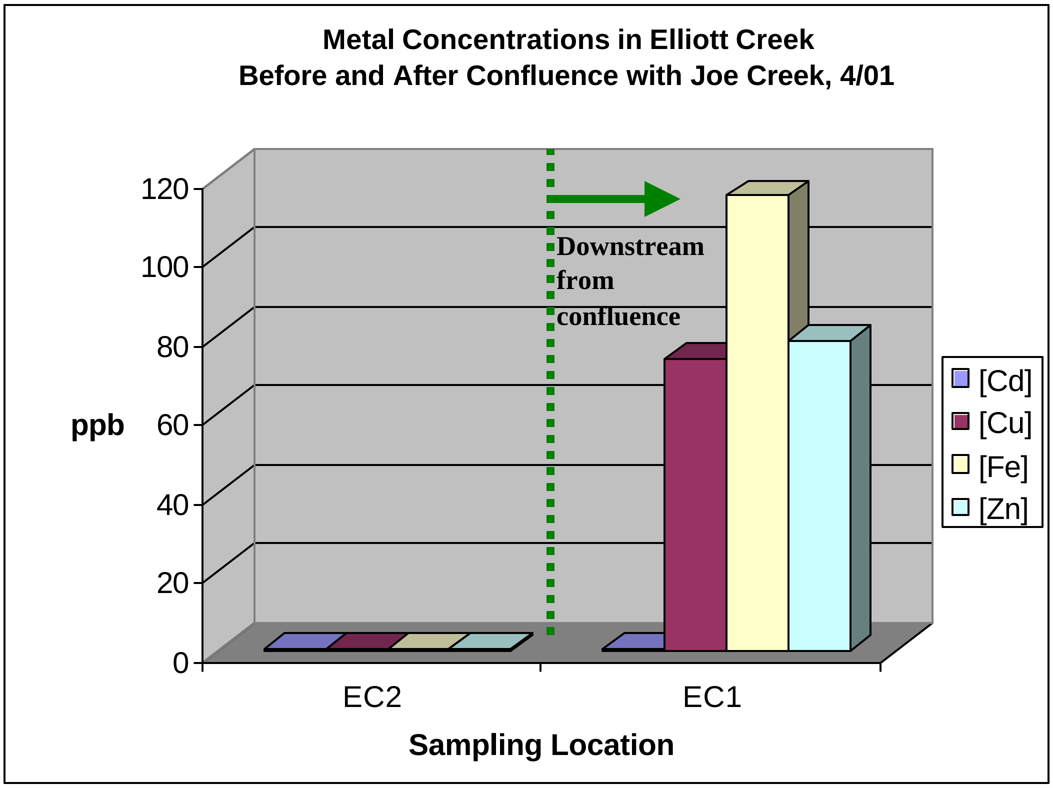


Chart 4

The sample results document the transport of dissolved metals from Joe Creek to Elliott Creek. Chart 4 displays the April 2001 data for cadmium, copper, iron, and zinc for the Elliott Creek samples taken above and below the confluence with Joe Creek. As can be seen from the chart, the sample taken upstream of the confluence with Joe Creek shows non-detects for all four metals, whereas the sample taken at the downstream site on the same day at nearly the same time revealed three of the metals—copper, iron, and zinc—were present at elevated concentrations. Thus, the data for metals document that the Blue Ledge Mine is releasing metals, some listed as hazardous substances, into Joe Creek. These dissolved metals are being transported to Elliott Creek. No data have been collected downstream of EC1. However, it is logical to conclude that during certain periods dissolved metals from the Blue Ledge Mine may travel well beyond EC1 to the Applegate River and Reservoir.

Exceedances of the primary drinking water MCLs and secondary drinking water standards are summarized in Table 1, page 19 and highlighted in the Data Display, Map 2, page 16. Exceedances of maximum contaminant levels (MCLs) set as primary drinking water standards for cadmium and copper were detected in the side stream running through the waste pile and in waters entering Joe Creek. Exceedances of secondary drinking water standards (designed to protect the aesthetics of the drinking water) also were observed for copper, iron, and zinc.

Table 1. Exceedances of Primary and Secondary Drinking Water Standards

Compound	Standard (ppb)	Measured Concentration (ppb)	Location	Date
Cadmium	5 (Primary standard / MCL)	40.3	BL1	April 2001
		13.4	JC6	August 2001
		15.6	JCS2	April 2001
Copper	1300 (Primary Standard / MCL) 1000 (State Secondary Standard)	6990	BL1	April 2001
		1830	JC6	August 2001
		2990	JCS2	April 2001
Iron	300 (State Secondary Standard)	11100	BL1	April 2001
		2310	JC6	August 2001
		998	JC4	April 2001
		586	JCS2	April 2001
		508	JC3	April 2001
		383	JC2	April 2001
		369	JC1	April 2001
Zinc	5000 (Federal Maximum Contaminant Limit Goal (MCLG)* and State Secondary Standard)	6800	BL1	April 2001

* MCLG is the maximum level of a contaminant in drinking water at which no known or anticipated adverse effect on the health of persons would occur.

The water quality sampling data also reflect exceedances of ALCs, promulgated by US EPA for the protection of aquatic life in California surface waters at 40 CFR § 131.38. Such criteria and exceedances will be discussed more fully in Section 4.0, Preliminary Identification of Resources at risk. However, in brief, the data show that AMD from the Blue Ledge Mine has caused dissolved metals to reach concentrations in Joe Creek toxic to aquatic life and unable to support fish and healthy macro-invertebrate populations.

3.2.3 Duration and Frequency of Releases of Hazardous Substances

The waste produced by the mining operations and left at the site, and the more than two miles of excavations in the mine itself are continuing sources of releases of AMD containing CERCLA listed hazardous substances. Releases of hazardous substances began with the development of the mine decades ago. One can conclude on the basis of geochemistry and site characteristics that such releases of hazardous substances have continued every year since and will continue with adverse consequences to natural resources unless control of AMD from the Blue Ledge Mine Site is implemented.

4.0 Preliminary Identification of Resources Potentially at Risk

Section 11.25 of the CERCLA regulations, 43 C.F.R. Part 11, requires a preliminary identification of potential exposure pathways to allow identification of resources at risk. In addition, the section requires a trustee following the regulations to identify areas where exposure or effects may have occurred or are likely to occur. It also encourages the trustee to consider concentrations of hazardous substances to which natural receptors might be exposed. Finally, it requires that the trustee following the regulations preliminarily identify potentially affected resources.

In Section 3.0 above, the Forest Service has addressed concentrations of hazardous substances released into the environment, including to Joe Creek and beyond, to which natural resources have been and could be exposed. The section will address other considerations outlined in Section 11.25 of the regulations.

4.1 Preliminary Identification of Exposure Pathways and Exposed Areas

There are a variety of pathways by which hazardous substances can enter the environment from the Blue Ledge Mine Site. Preliminarily, the Forest Service has identified surface water, movement of contaminated particulates, groundwater, and food chain as important exposure pathways for natural resources.

4.1.1 Surface Water and Particulate Movement

Surface Water Transport of Dissolved Metals

An average annual precipitation in the vicinity of the mine of 138 inches of snow and 33 inches of rain (Hundhausen 1947) results in substantial runoff from the mine as well as percolation through the waste piles below the mine. At 4,800 feet above sea level, the Blue Ledge Mine is located in a transient snow zone where periods of rain-on-snow events can occur, which creates a high risk of mass wasting and surface erosion (USFS 1995).

One-third of the Joe Creek watershed is located within the transient snow zone (above 4,000 feet) and can receive moisture either as rain or snow. Given that most of the precipitation occurs during winter months, rain-on-snow events are not uncommon and are the primary cause of flooding in the Upper Applegate watershed. Pulses of runoff occurring at these times create a high risk for mass wasting and surface erosion (USFS 1995).

At the Blue Ledge Mine, waste rock and exposed minerals in abandoned underground workings, excavations, etc. are oxidized during all times of the year, except in cases when rock surfaces are submerged. However, such processes are greatest during the dry period from July to November. Thus, it follows that high flow periods of the spring offer the greatest opportunity to flush the metals that have accumulated from the oxidation of the summer months and transport them downstream.

Consistent with this conceptual site model for transport and exposure, as noted in Section 3.2.2 above, surface water shows highly elevated concentrations of metals, as compared to background and upstream locations unaffected by AMD, during the spring high flow period. Data show that dissolved metals released from the mine can be traced to effects in Elliott Creek as a clear gradient exists from Elliott Creek upstream to the mine (see Charts 2-4, pp. 19-20).

Spring months are not the only months of the year in which surface water can be a pathway of exposure to resources of the national forest. In fact, the same water quality data discussed above show very high metal concentrations in summer in a sample downstream of waste disposal areas and collapsed mine portals not visible from FS Road 1060 (JC6) as well as from a spring near Joe Creek (JCS2). Historical accounts of waste disposal suggest that this seep may well be in an area in which waste rock was disposed at the bottom of the mountain (see Charts 2-4, pp. 19-20).

Sediment Transport -- Transport of Fines from the Waste Disposal Areas

Site visits and photos of the site indicate that a majority of the waste material below the mine is in the form of fines the size of coarse sand, intermixed with small rocks 6 cm or smaller.

As a result, particles from Blue Ledge Mine waste rock piles or precipitates from mine drainage are likely to be entrained during runoff and carried into Joe Creek and downstream. Particle transport by streams depends on stream velocity. Moderate currents (20-50 cm/s) move sand and smaller particles; these currents are common in most rivers. The suspended load of a stream can carry fines even at relatively low flows, lower than those of mountain streams like Joe Creek and Elliott Creek. At higher flow velocities and volumes, fine particles may be carried for miles before the carrying capacity of the water is reduced sufficiently so that the sediment load is deposited.

The Joe Creek watershed is long and narrow and ranges in elevation from 6,200 feet at the headwaters to 2,100 feet at its mouth. Two reaches of Joe Creek were surveyed and identified based largely on changes in stream gradient (Siskiyou Research Group 2002). Reach 1, extending from the mouth for 1.69 miles upstream to Manzanita Gulch, exhibited a stream gradient that averaged 7%. Reach 2, extending from the gulch to the mine site (1.71 miles), exhibited an average gradient of 18%. It is therefore likely that during individual high flow events, or as a result of successive high flow events, fine particles can be carried through Joe Creek to Elliott Creek, the Applegate River, and possibly well into the Applegate Reservoir.

Transport of metals and hazardous particles is widely known. In one study of a stream downstream of a mine, 98% of excess copper, 91% of excess arsenic, and 70% of excess cadmium measured in the riparian zone was deposited by a river transporting contaminated sediments originating from upstream mining and smelting activities. This study showed that metal concentrations in contaminated sediments did not decrease with distance downstream from the source areas (Rice et al. 1985).

There is a strong likelihood that particles originating from the Blue Ledge Mine have been transported from their origin, by weathering, mass wasting, and runoff, downslope and downstream as far as the Applegate Reservoir.

4.1.2 Groundwater

Another way for polluted discharges from the mine and the waste piles to potentially reach natural resources of the National Forest is via groundwater flow. According to the infiltration theory of runoff (Chorley 1978), precipitation on a hillslope will be absorbed if the intensity is less than the infiltration capacity. As infiltration capacity is exceeded during high precipitation periods, overland flow is produced. Both subsurface and overland flow occur at the Blue Ledge Mine Site.

In the area surrounding the mine, precipitation that infiltrates to groundwater is very likely impacted by AMD through its contact with mine waste materials as described above. Depending on the local geology, this water may continue to generate AMD as it percolates downward through sulfide-bearing rocks below the surface or through fractures and voids where sulfide minerals are also present. This impacted groundwater emerges downslope at seeps and enters streams, carrying with it elevated metals concentrations.

Precipitation also enters abandoned adits and mine shafts. The same processes that generate AMD within the waste rock outside the mine also occur on the vast surfaces within the mine as they are exposed to moisture and oxygen. This impacted water likely flows from the mine's workings through preferential subsurface pathways along the rock's bedding surfaces and associated voids and fractures. The predominant strike of the schist below the mine averages North 10^{o} East (Hundhausen 1947), indicating groundwater likely flows from the mine to the north and south, working its way along these pathways until it surfaces downslope of the mine. This is another pathway by which impacted groundwater emerges at seeps and enters streams, creating effects on surface water resources and a pathway of exposure for biologic resources.

At the Blue Ledge Mine, most of the AMD-generating oxidation of waste rock and exposed minerals in abandoned excavations occurs during the dry period from July to November. Most metals mobilized by infiltrating precipitation enter the groundwater system as leachate during the wet period from December to June.

4.1.3 Food Chain Pathways

In polluted aquatic ecosystems the transfer of metals through the food chain can cause high concentrations in invertebrates and toxicity in fish (Dallinger 1985). When invertebrate species sensitive to the metal contamination are eliminated, metal-tolerant food organisms can become dominant. Their tolerance may be based on their ability to accumulate excessive amounts of metals, which would lead to increased dietary exposure among fish predators (Timmermans 1989, Woodward 1995).

Studies show that heavy metals, such as cadmium, copper, and zinc released from the Blue Ledge Mine, may be stored in various tissues of organisms including the liver, muscle, skin, or gills (see Besser et al. 1995). The amount of metal storage varies with the metal and pathways of uptake (e.g., via water, sediments, food). For the foregoing reasons, the food chain has been identified as an exposure pathway at the Blue Ledge Mine Site.

4.2 Exposed Areas

The Forest Service has preliminarily identified the areas in and around 1) Joe Creek, 2) Elliott Creek downstream of Joe Creek, 3) the Applegate River downstream of Elliott Creek, and 4) the Applegate Reservoir as areas where exposures to hazardous substances released from the Blue Ledge Mine can occur. The Forest Service reached this conclusion for the following reasons.

First, as noted above, it is likely that fines from the Blue Ledge Mine waste are transported via Joe Creek to Elliott Creek and to the Applegate Reservoir. It is well documented that such fines from mining operations can offer a continuing source of releases of hazardous substances locations far downstream of the mine (Rice et al. 1985).

Second, analyses of water samples taken in April 2001 in Elliott Creek upstream and downstream of the confluence with Joe Creek document that dissolved metals from the mine have been transported to Elliott Creek (See discussion in Section 3.2.2 above). There are no samples taken downstream of EC1 (see Map 2); however, transport of dissolved metals beyond this sample location is likely.

Third, to the extent bioaccumulation of hazardous substances has occurred, natural resources in areas other than these water-bodies could be affected.

4.3 Affected and Potentially Affected Resources

This subsection presents a list of resources that the Forest Service has preliminarily identified as potentially affected natural resources under its trusteeship. Given the limited nature of the investigation allowed by a PAS, this list is preliminary. With further assessment the list will be refined to reflect a more complete understanding of natural resource injury that follows a natural resource damage assessment.

4.3.1 Surface Water Resources

Recent data presented in this PAS demonstrate that releases from the Blue Ledge Mine have increased the concentrations of metals, which are listed hazardous substances, to such levels that the water of Joe Creek is potentially injurious to human health and is toxic to aquatic organisms.

As noted above, elevated dissolved metals were observed downstream of Joe Creek in the April 2001 sample round above background and upstream locations unaffected by AMD. For example, copper was not detected at JC5, but was detected downstream at JC4 at 790 ppb. As noted in Section 3.2.2 above, the data document violations of primary and secondary drinking water standards. Moreover, a comparison of the data with aquatic life criteria (ALCs) for surface waters demonstrates that the AMD has caused concentrations well in excess of ALCs in Joe Creek and Elliott Creek. ALCs include contaminant maximum concentrations (CMCs) and contaminant continual concentrations (CCCs). CMCs are the highest concentration of a pollutant to which aquatic life can be exposed for a short time (one hour) without deleterious effects. Thus, CMCs are acute ALCs. CCCs are chronic ALCs and equal the highest concentration of a pollutant to which aquatic life can be exposed for an extended time (four days) without deleterious effects. EPA regulations promulgated for the state of California define both acute and chronic ALCs. Toxicity of metals to aquatic organisms is often dependent upon hardness of the water. As a result, in the EPA regulations ALCs for metals including cadmium, copper, and zinc are expressed as a function of hardness, as shown in Table 2 below.

Table 2. Aquatic Life Criteria as a Function of Hardness

Metal	Acute ALC	Chronic ALC
Cadmium	ALC= e^(1.128*ln(hd)-3.6867)	ALC= e^(.7852*ln(hd)-2.715)
Copper	ALC= e^(.9422*ln(hd)-1.7)	ALC= e^(.8545*ln(hd)-1.702)
Zinc	ALC= e^(.8473*ln(hd)+.884)	ALC= e^(.8473*ln(hd)+.884)

Using the above equations and hardness data, ALCs were calculated for cadmium, copper and zinc for each sampling site in the September 2000, April 2001, and August 2001 sampling rounds. These ALCs were compared with the concentrations of the applicable metal at the site. The results are summarized in Tables 3 through 5.

Table 3. Exceedances of Aquatic Life Criteria for Cadmium

	September-00			April-01			August-01		
Location	Conc.	Acute ALC	Chronic ALC	Conc.	Acute ALC	Chronic ALC	Conc.	Acute ALC	Chronic ALC
PG1	ND	2.9	1.8	ND	1.5	1.1	ND	2.7	1.7
EC1	ND	3.3	2.0	ND	1.4	1.1	ND	2.5	1.6
EC2	ND	3.3	2.0	ND	1.6	1.2	ND	2.3	1.5
JC1	ND	3.3	2.0	1.3	1.4	1.1	ND	3.3	2.0
JC2	ND	3.2	1.9	1.7	1.4	1.1	ND	3.3	2.0
JC3	0.5	1.6	1.2	2.5	0.80	0.74	1.7	1.6	1.2
JC4	ND	1.4	1.1	4.1	0.91	0.81	ND	1.4	1.1
JC5	ND	1.5	1.2	ND	0.70	0.67	ND	1.5	1.2
JC6				ND	0.34	0.40	13.4	1.9	1.4
JCS1	ND	2.0	1.4	ND	1.2	0.95	ND		
JCS2	3.7	1.6	1.2	15.6	2.1	1.5			
BL1				40.3	1.2	1.6			

Table 4. Exceedances of Aquatic Life Criteria for Copper									
	September-00			**April-01**			**August-01**		
Location	Conc.	Acute ALC	Chronic ALC	Conc.	Acute ALC	Chronic ALC	Conc.	Acute ALC	Chronic ALC
PG1	ND	9.6	6.6	ND	5.5	4.0	ND	9.2	6.4
EC1	ND	11	7.3	73.5	5.2	3.8	ND	8.5	6.0
EC2	ND	11	7.3	ND	5.8	4.2	ND	7.9	5.5
JC1	ND	11	7.3	280	5.3	3.9	ND	11	7.4
JC2	11.4	10	7.1	309	5.3	3.9	ND	11	7.4
JC3	30.8	5.9	4.2	436	3.3	2.5	101	6.0	4.3
JC4	53.7	5.2	3.8	790	3.7	2.8	83.9	5.3	3.9
JC5	ND	5.7	4.1	ND	2.9	2.3	ND	5.7	4.1
JC6				ND	1.6	1.3	1830	6.9	4.9
JCS1		7.1	5.1	ND	4.5	3.3	ND		
JCS2	407	5.9	4.3	2990	7.5	5.3			
BL1				6990	8.3				

Table 5. Exceedances of Aquatic Life Criteria for Zinc*						
	September-00		**April-01**		**August-01**	
Location	Conc.	Criteria	Conc.	Criteria	Conc.	Criteria
PG1	8.7	85	ND	52	ND	82
EC1	2.6	94	78.3	49	ND	77
EC2	ND	94	ND	54	ND	71
JC1	21.9	94	287	50	54.2	95
JC2	29.1	92	360	50	71.3	95
JC3	50.7	55	481	33	278	56
JC4	70.4	49	774	36	144	50
JC5	ND	53	ND	29	ND	53
JC6	ND		ND	17	2750	64
JCS1	3.6	65	ND	43		
JCS2	727	55	2880	68		
BL1			6800	75		

* - Equations for Acute and Chronic ALCs are the same for zinc

Exceedances of the calculated ALCs are highlighted in green. *At least* one exceedance of the ALCs for each metal was detected during each sampling round. Particularly telling are the data taken in the Spring 2001 sampling round during the wet season when AMD releases are expected to be the highest. In the mine discharge, acute ALCs for cadmium, copper, and zinc were exceeded 34-, 844-, and 91-fold, respectively. Cadmium exceedances of acute and chronic ALCs were noted as far downstream as JC1. Exceedances for copper and zinc (both acute and chronic ALCs) were detected in Elliott Creek. The data clearly show metal concentrations above those protective of aquatic communities.

Elevated dissolved metals are not the only injuries to aquatic resources from the AMD. Injuries to aquatic resources also are likely to have resulted from the transport of contaminated particles downstream. Although sediments samples have not yet been taken, as described below the site characteristics are favorable for such contaminant transport. Such transport could have occurred as far as downstream as the Applegate Reservoir. Given the years of release of such contaminated fines, contaminated sediments are likely to be found in depositional areas in Joe Creek, Elliott Creek, and the Applegate River and Reservoir, offering a source of continuing releases of hazardous substances. Such contamination is considered an injury to surface water resources under the regulations. The fact that surface water resources well beyond Joe Creek could be compromised is born out by recent studies on the toxic effects of metals.

The conditions at the Blue Ledge Mine can be compared to those of the Methow Valley on the eastern slopes of the north Cascade Mountains in Okanogan County, Washington. The Methow basin is similar to the Blue Ledge Mine site in that the mined ore deposits are rich in sulfides and AMD has been the cause of elevated metals concentrations in runoff to streams. A recent study conducted in the Methow Valley found reduced growth and increased mortality among trout maintained in pens downstream from the mines despite the fact that water was meeting water quality standards *and* concentrations of metals were *at detection limits* (Peplow 2002). Such toxic affects were seen 10 km from the mine site. Sediments contaminated by releases from upstream abandoned mines were identified as the cause.

In summary, the aquatic resources of the National Forest have been injured by the AMD from the Blue Ledge Mine. Such injuries extend to Elliott Creek and likely to the Applegate Reservoir.

4.3.2 Groundwater Resources

No groundwater samples have been collected. However, samples have been collected in seeps that have daylighted near the mine. The samples show that groundwater has been affected. Such samples show elevated concentrations of metals. As a result, principles of geochemistry, an understanding of AMD, and such data from seeps, groundwater resources, under the trusteeship of the Forest Service, are likely to have been affected at the Blue Ledge Mine Site. Daylighted groundwater at the sample location JCS2 shows metal concentrations in exceedance of both drinking water standards and acute and chronic ALCs. A sample taken at JCS2 in April 2001 exceeded the MCL for copper and the state secondary standard for iron. Samples taken at JCS2 in September 2000 and April 2001 exceeded acute *and* chronic ALCs for cadmium, copper, and zinc. In April 2001, the acute and chronic ALCs for copper were exceeded 400-fold and 566-fold, respectively; the same sample showed an exceedance of the zinc ALCs of 42-fold. These data indicate that AMD at the mine has had a negative impact on groundwater.

4.3.3 Biologic Resources

Survey data and water sampling indicate that AMD from the Blue Ledge Mine is resulting in widespread impacts to aquatic life in Joe and Elliott Creeks. As discussed in Section 4.3.1, concentrations of cadmium, copper, and zinc exceed acute and chronic ALCs intended to protect of aquatic communities in California. Literature, some of which was used to derive the ALCs, show that the metals concentrations found in Joe Creek downstream of the mine, have adverse effects, including mortality, on macroinvertebrates, fish, and amphibians. Surveys confirm that such adverse effects have occurred due to AMD releases from the Blue Ledge Mine.

Macroinvertebrates

Surveys of macroinvertebrates indicate injuries have occurred due to AMD releases from the Blue Ledge Mine. Freshwater invertebrates are ubiquitous; even the most polluted or environmentally extreme lotic environments (those with swift flowing waters) usually contain some representatives of this diverse and ecologically important group of organisms (Hauer and Resh 1996). Healthy aquatic systems of western United States montane rivers typically support complex and diverse macroinvertebrate communities that include mayflies, stoneflies, caddisflies, and Diptera (midges, black flies, crane flies, etc.). However, survey data taken indicate that Joe Creek cannot support even a marginal macroinvertebrate community.

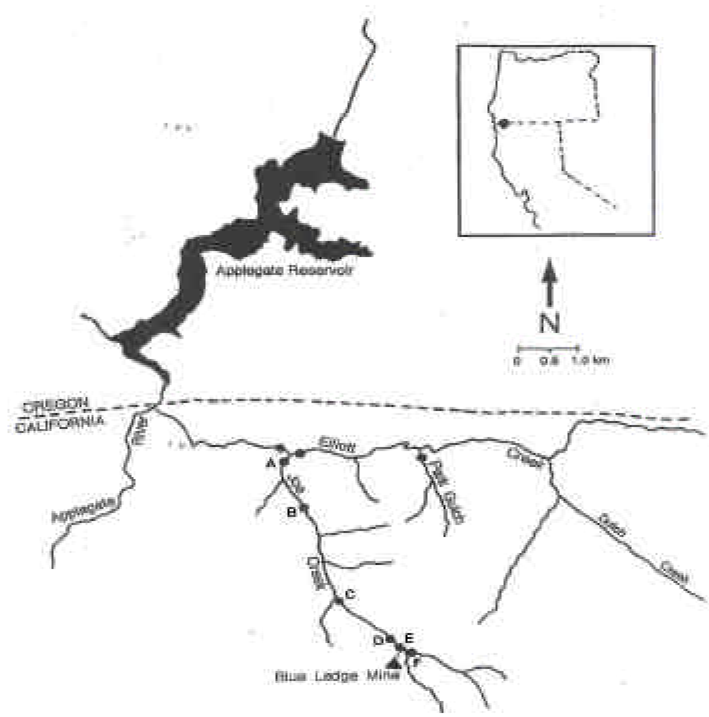
In September 2000 and May 2001, the Forest Service commissioned macroinvertebrate surveys to investigate the effect of the Blue Ledge Mine on the macroinvertebrate community within the National Forest up- and downstream of the Blue Ledge Mine (Parker 2000, 2001). The Rapid Bioassessment Procedure was used for the two Joe Creek surveys as a method to identify community structure while minimizing time spent sorting and identifying organisms from large samples (Resh and Jackson 1993). This method provides a comparison between reference sites and sites that may be affected by hazardous substances.

As shown in Map 3, the sampling sites are in the same locations as those of the 2000 and 2001 sample sites, unless there was no water present. The primary reference sites are located upstream of the mine area (Site F) and on Park Gulch (see Map 3). Park Gulch was selected as an appropriate reference site because it is the northerly extension of the Blue Ledge mineralization. It is also the only location within the watershed with similar mineral influences as that found in Joe Creek and is not influenced by AMD from the Blue Ledge Mine. Two sites are located on Elliott Creek approximately 50 to 100 m upstream and downstream of the confluence with Joe Creek. The surveys documented a diverse invertebrate community above the mine site; whereas sample locations downstream of the mine discharge area in Joe Creek were heavily impacted compared to reference sites (Parker 2000, 2001). (See Charts 5 and 6)

In the fall 2000 survey, macroinvertebrate density and diversity were dramatically reduced from the mine site to 3 km below the mine, compared to the community sampled upstream of mine discharges (Parker 2000). Macroinvertebrate densities and diversity at the farthest downstream sites did not approach those observed within Elliott Creek and at Park Gulch.

The spring 2001 survey, conducted in May when there was considerable surface flow from the mine tributary entering Joe Creek, indicated even greater impacts on the benthic invertebrate community than did the fall survey (Parker 2001). From the tributary that runs through the main waste pile on the mountainside to a distance of over 2 km downstream, macroinvertebrates were virtually eliminated. As noted, invertebrate densities were extremely low for the *entire* length of Joe Creek downstream of the mine. The decrease in invertebrate densities observed downstream of the mine is correlated with the direct *and* indirect effects of the elevated metal concentrations. Direct effects result from the exposure of invertebrates to elevated dissolved metals associated with the leachate from the Blue Ledge Mine – copper, cadmium, zinc, and iron. Indirect effects caused by the releases of hazardous substances (dissolved metals) also contributed to the injury observed. A comparison of the fall and spring survey suggests that the adverse effects to macroinvertebrate communities and stream health are most severe during the spring high flows (Parker 2001). During spring, as supported by water quality data collected in 2000 and 2001, high volumes of metals are pulsing through the system after a summer of oxidation of the sulfide deposits still found in the mine and its waste.

Metals data taken in Joe Creek indicate that the lack of macroinvertebrates in Joe Creek is due to AMD releases from Blue Ledge Mine. Streams experiencing environmental stresses often have reductions in benthic macroinvertebrate density and diversity (Barbour et al. 1995). Norris et al. (1990) showed significant reductions in density and diversity of mayflies, stoneflies, and caddisflies in response to copper mine effluent. Concentrations of copper as low as 25 ppb (790 ppb in Joe Creek; 73.5 ppb in Elliott Creek) have been correlated with 67-100% reduction in ephemeroptera populations and 16-30% reduction in plecoptera populations (Clements, et al., 1992). Clearly, concentrations in Joe Creek are much higher than these levels and result in the low numbers of macroinvertebrates seen in Joe Creek. High levels of zinc (up to 774 ppb in Joe Creek; 78.3 ppb in Elliott Creek) are also a potential source of injury to aquatic invertebrates. Studies have shown that concentrations of 37 ppb result in 50% mortality rates in embryos of some diptera species (EPA 1980; EPA 1987). Concentrations of 30 ppb have been shown to reduce growth rates as well as cause mortality in ephemeroptera larvae, and concentrations of 100-300 ppb resulted in 100% mortality (Hatekeyama, 1989).



Map 3

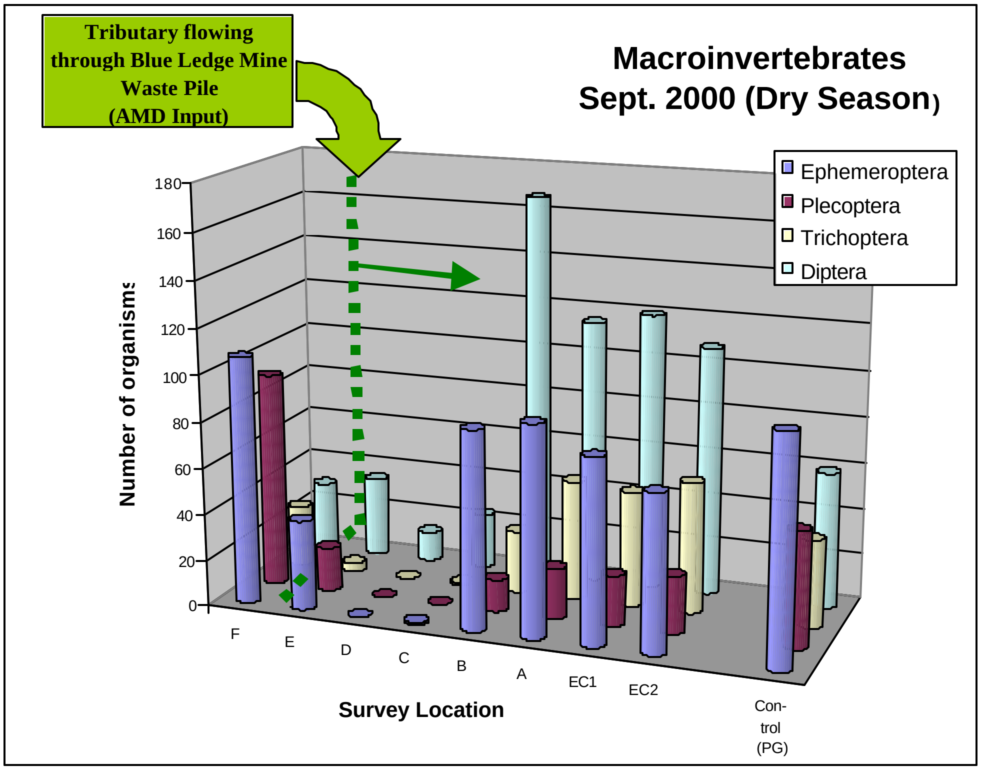


Chart 5

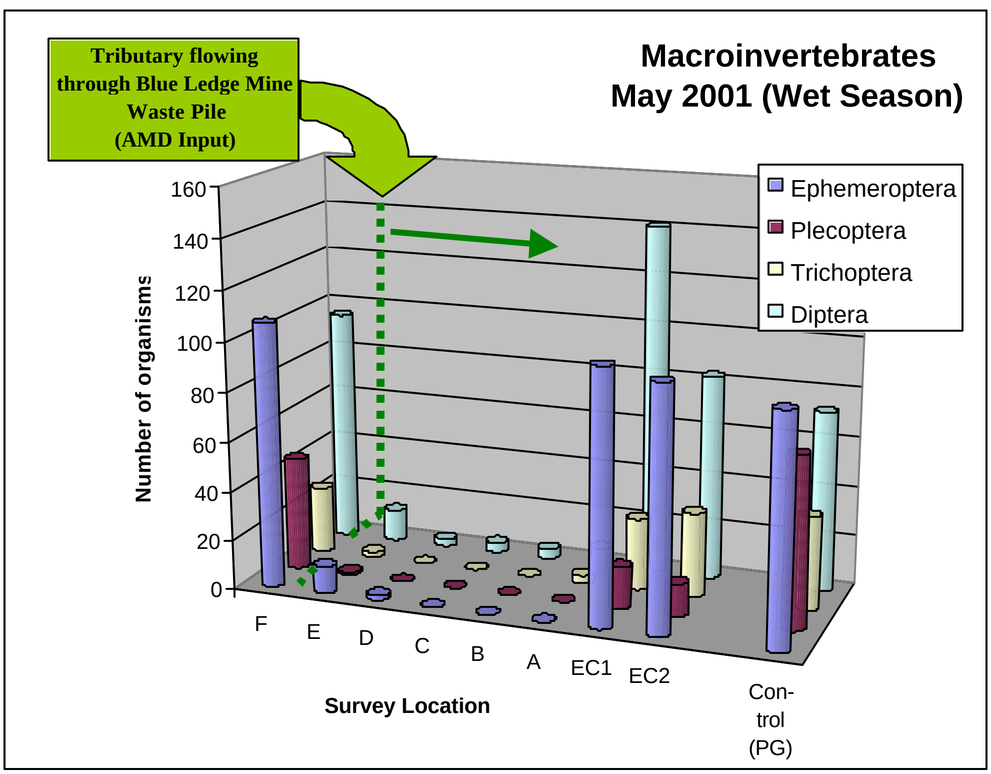


Chart 6

Amphibians

Stream-dwelling amphibians were studied during the fall and spring invertebrate surveys (Parker 2000, 2001). Various life stages of tailed frog (*Ascaphus truei*) and Pacific giant salamander (*Dicamptodon tenebrosus*) were found upstream of the mine in both surveys; however, very few, if any, were found along Joe Creek from the mine to the confluence with Elliott Creek. These data provide evidence of injury to amphibians from AMD downstream of the mine.

Amphibian survey data are highly indicative of AMD effects on amphibian populations downstream of the Blue Ledge Mine. Various life stages of tailed frog (*Ascaphus truei*) and Pacific giant salamander (*Dicamptodon tenebrosus*) were found upstream of the mine in both surveys; however, no amphibians were counted at the JC4 site directly downstream of the mine and a maximum of only three was found at any site further downstream (See Chart 7). This pattern is consistent with metal concentration data taken in Joe Creek, particularly that of copper. The concentrations of copper found in Joe Creek are associated with adverse effects and mortality in amphibians. In previous experiments with frog species, copper concentrations of 10 ppb resulted in 34-39% mortality rate in embryos within four days of hatching (Birge and Black, 1979). Copper was detected at 79 times this level at the JC4 site and from 28 to 43.6 times this level at the other Joe Creek sites downstream of the mine where amphibian impacts were detected.

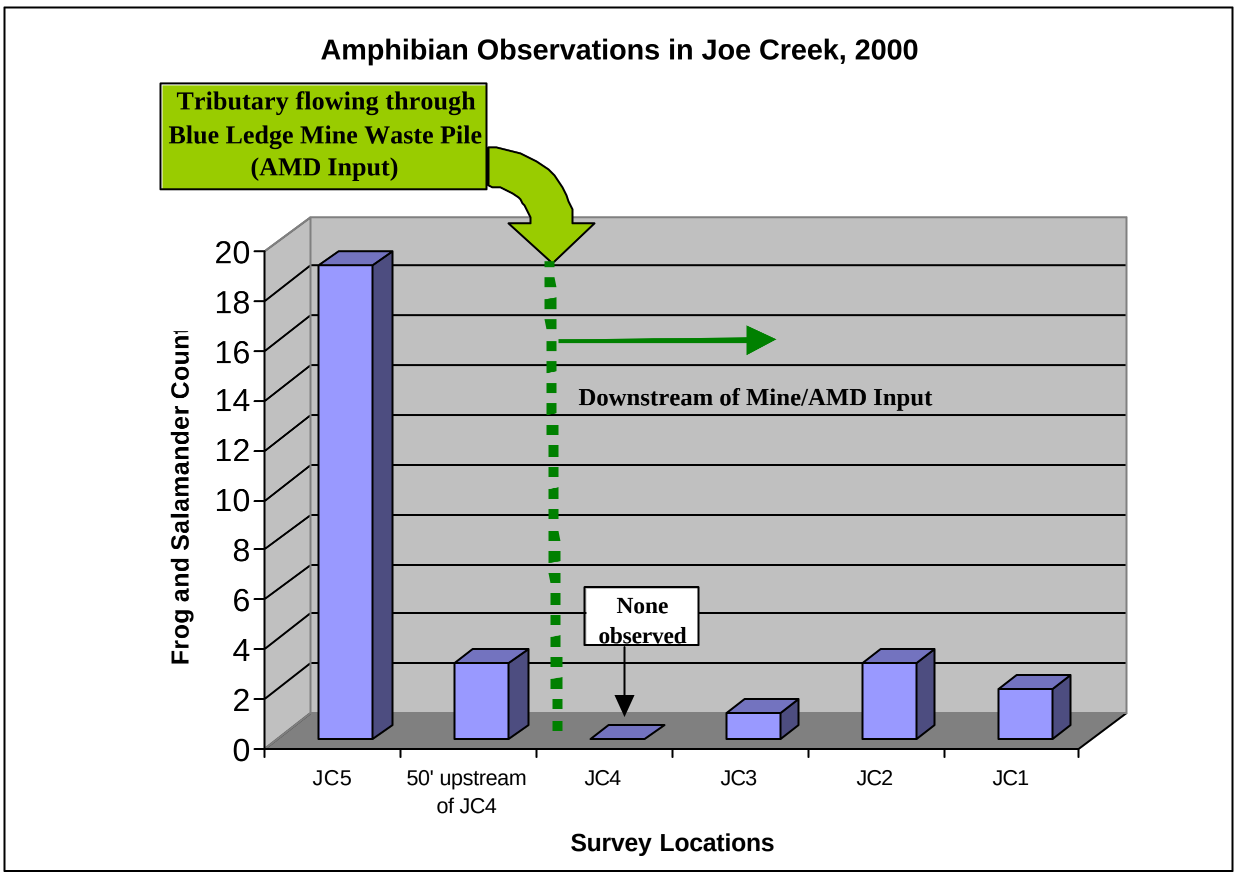


Chart 7

Fish

Data from fish surveys taken on Joe Creek, examined in combination with the water quality data, demonstrate that hazardous substances from the Blue Ledge Mine have caused injury to fish resources under the trusteeship of the Forest Service. Fish surveys were conducted by the Forest Service in September 2000 (Reid 2000). Data from these fish surveys are displayed on Chart 8. Rainbow trout (*Oncorhynchus mykiss*) and unidentified sculpins were found in Elliott Creek and in Joe Creek immediately upstream of the confluence with Elliott Creek. No fish were found upstream of this sampling location. Reid noted that trout captured within the mouth of Joe Creek were all young-of-the-year. He postulated that these fish probably entered Joe Creek from Elliott Creek rather than being the result of spawning in Joe Creek because no adult trout were found in Joe Creek.

The absence of fish in Joe Creek is particularly striking when displayed on a map of the watershed showing the presence and absence of fish. Joe Creek is the only stream where fish are absent in the watershed except for small reaches of certain streams where there are likely to be physical barriers to fish (see Map 4, p. 32).

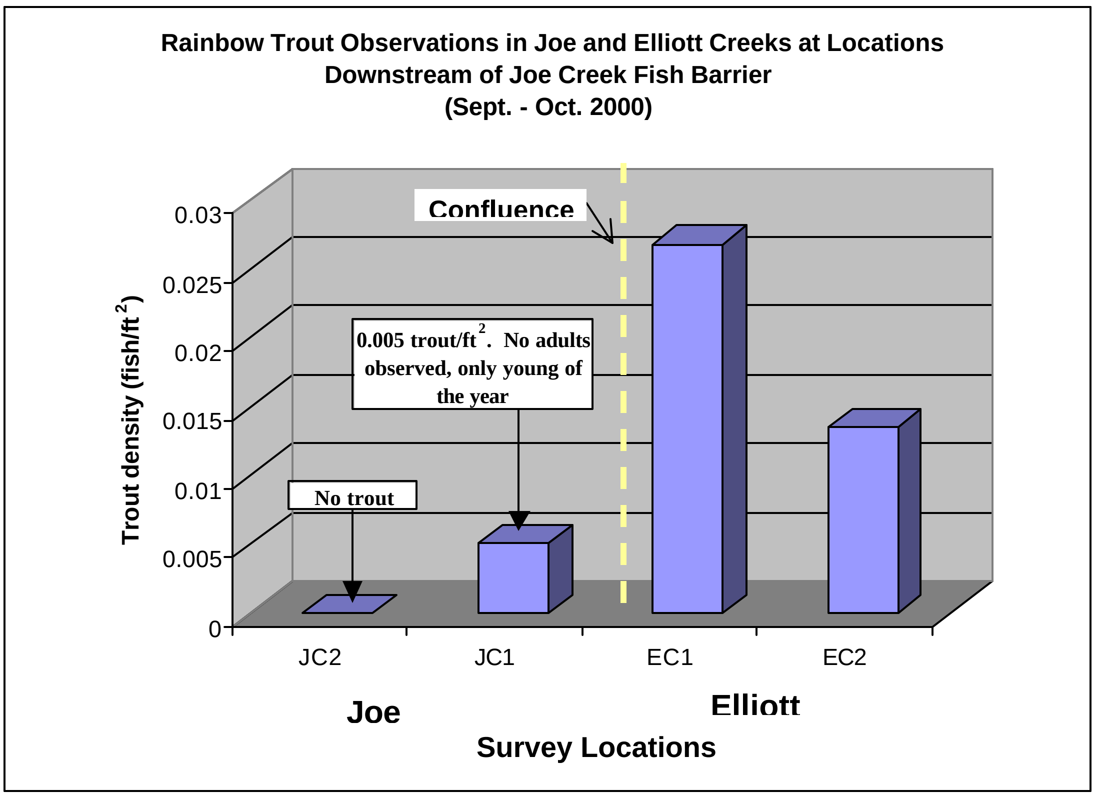
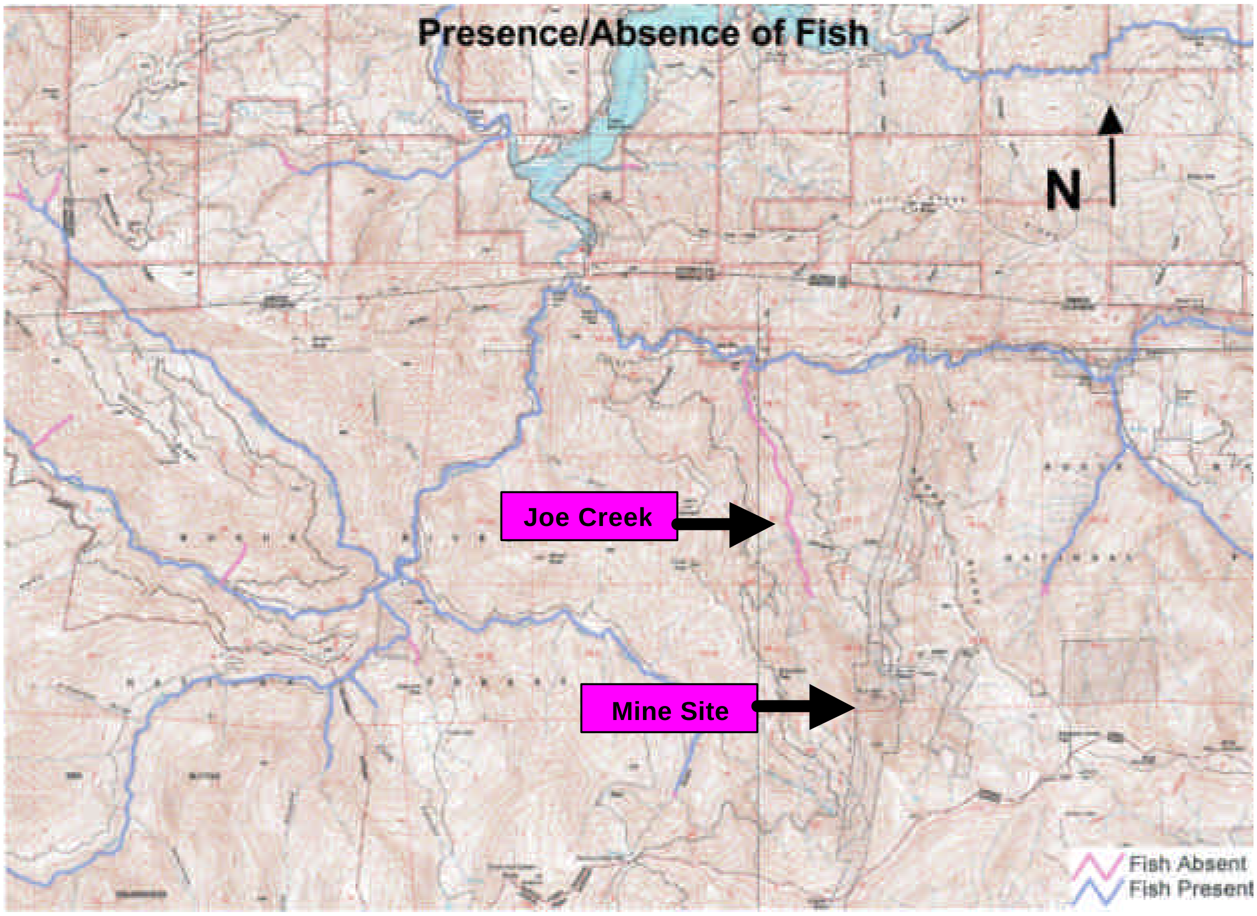


Chart 8



Map 4

Although impacts to fish from AMD have long been suspected, until the Forest Service undertook a stream survey in 2001 it had not ruled out the possibility that physical features of the stream were responsible for limiting or excluding fish distribution. Thus, the express purpose of this study was to eliminate from consideration such explanation for the apparent lack of fish in Joe Creek (Siskiyou Research Group 2001). This study concluded that "the results of this survey show no physical reason Joe Creek could not support a resident trout population in the lower 2.04 miles" (Siskiyou Research Group 2001). The study did find barriers to fish distribution, however, within the 1.36 miles closest to the Blue Ledge Mine Site.

Metal concentrations detected in Joe and Elliott Creeks are much higher than those shown to have adverse effects and high mortality rates in rainbow trout and other fish. Studies have shown a 50% mortality rate in adult trout after 96 hours of exposure to water with just 13.8 ppb copper (Buhl and Hamilton, 1990). Concentrations of copper in Joe Creek in areas downstream of the Joe Creek fish barrier have been found up to 22.4 times this level in Joe Creek and 5.3 times this level in Elliott Creek downstream of its confluence with Joe Creek. Concentrations of zinc found in Joe Creek (up to 360 ppb in Joe Creek downstream of the fish barrier) have also been found at levels resulting in harmful effects to fish. The LC-50 for zinc in rainbow trout alevins and larvae is reported as 10 ppb; the LC-50 for rainbow trout fry ranges from 90 to 93 ppb (EPA 1980; EPA 1987; Spear 1981). Avoidance in cutthroat trout was found downstream of a mining waste site in which metal concentrations were similar to or below those found at the Blue Ledge Mine (12 ppb copper; 1.1 ppb cadmium; 50 ppb zinc) (Hansen, et al. 1999). Reduced growth and delayed sexual maturation has also been associated with exposure to elevated concentrations of As, Cd, Cu, Pb, Mn, and Zn (Kemble 1994). Cell death occurs in Cu-exposed fish (Kamunde et al., 2001) and increased mortality occurs when trout consume contaminated sediments (Mount et al., 1994).

Mammals and Avian Resources

No data have been collected that would help shed light on metal exposures to birds and mammals. However, because such species frequent the area in which there is surface water contaminated by metals released from the Blue Ledge Mine and also because there is a possible food chain pathway of exposure to such species, mammals and birds are considered by the Forest Service to be resources potentially affected by the releases from the Blue Ledge Mine.

5.0 POTENTIALLY RESPONSIBLE PARTIES

Section 107 of CERCLA, 42 U.S.C. § 9607, makes certain categories of parties liable for natural resource damages resulting from a release of a hazardous substance. Parties liable under the statute include current owners and operators of a facility from which there is a release of hazardous substances and owners and operators of a facility at the time of disposal/release of hazardous substances.[6] Because hazardous substances have been released in all years since the mine's development and operation, potentially responsible parties, absent a defense or exclusion from liability, include the current owners and operators of the site and all prior owners and operators. This subsection presents the chronological sequence of the owners and operators of the Blue Ledge Mine, starting from the past to the present. A summary of ownership is included as Table 2.

Sometime in the period 1896-1898, the Blue Ledge copper-zinc sulfide deposits were discovered by local miners, and limited development of the mine occurred over the next few years. Ownership reportedly fell to L.F. Cooper, William H. Hamilton, and others of Crescent City in 1902 (Aubury 1902) and in June 1904 the mine was purchased by John R. Allen and Associates of New York. (Kramer 1999) The mine was subsequently expanded and in 1905 it was sold to Robert Safford Towne, president of Compania Metalurgica Mexicana (CMM). Chartered in New Jersey in 1890, CMM was the centerpiece of an empire of several railroads, a timber company, a smelter, and mines all located largely in Mexico. At Towne's death in 1916, his estate was appraised at $2,500,000. The value of all the property he controlled, but did not own, was even greater (Bernstein 1964).

Towne's vehicle for developing the Blue Ledge was the Blue Ledge Mining Company. He invested nearly $2 million in the operation (O'Hara 1964). Ledgers from the period 1905-1909 written by F.W. Carnahan, Towne's chief engineer on the site, document expansion and exploration of the mine.

Although the Blue Ledge claims were patented in 1911, the mine was inactive between 1909 and 1916. In 1913, the mine was transferred to the Mexican Smelting and Refining Company, a subsidiary of CMM.

As early as 1913, the American Smelting and Refining Company (ASARCO) became financially involved with the Blue Ledge. ASARCO is today a world leader in the production of nonferrous metals and was founded in 1899 by financial baron Henry H. Rogers. By 1900, the Guggenheims gained control of ASARCO, and in 1905 they floated securities to purchase, among other properties, the smelter at Tacoma, WA (Jacobson 1991). A Blue Ledge Mine property report (1990) lists ASARCO as the mine owner in 1913 (Mattinen 1990), but other sources attribute ownership to the Mexican Smelting and Refining Company (Hundhausen 1947). In either case, CMM came under ASARCO control in 1923 when ASARCO was given a 60% interest in a number of Towne mines. Towne's heirs, however, still held title to the properties.

[6] 42 U.S.C. § 9607(a)(1)-(4).

Table 6. History of Blue Ledge Mine Ownership and Operations

Year	Owner/Lessee/Operator	Operations Conducted
1902	L.F. Cooper, William H. Hamilton, and others of Crescent City (owner)	Limited development
1904	John R. Allen and Associates, New York (owner)	Limited development
1905	Blue Ledge Mining Company (owned by Robert Safford Towne, President of Compania Metalurgica Mexicana (CMM)) (owner)	Majority of mine development: diamond drill holes and over 2,500 feet of drifts, raises, winzes, and adits
1913	Mexican Smelting and Refining Company, a subsidiary of CMM (owned either by Towne or ASARCO) (owner)	8,576 tons of ore shipped from 1917-1920
1923	Towne Mines, Inc., a subsidiary of the American Smelting and Refining Company (ASARCO) (owner)	
1930	Dr. J.F. Reddy of Medford, OR and George Hughes of Spokane, WA (lessee)	2,575 tons of ore shipped in 1930 (obtained largely by sorting the ore dump)
1935	Towne Mines, Inc., a subsidiary of the American Smelting and Refining Company (ASARCO) (owner)	Exploration (1940-1942); Sampling, mapping, and drilling by U.S. Bureau of Mines (1947)
1956	Transcontinental Resources (owner)	
1974	Michelle E. Tracey Trust (owner)	
1981	Freeport Exploration (lessee)	Soil surveys, mapping, and 13,461 feet of rotary drilling
1984	Long Lac Mineral Exploration (joint venture)	9,588 feet of core drilling
1991	Sikaman Gold Resources (owner)	
1998	Blue Ledge Corporation (c/o Robert J. Custis, Esq.) (owner)	
2002	Michelle E. Tracey Trust (owner)	

CMM was integrated into a holding company, Towne Mines, Inc., which in turn was directed by ASARCO (Bernstein 1964). A 1925 mining report remarked that the Blue Ledge was reportedly sold to Guggenheim interests but was still assessed to the Mexican Smelting and Refining Company (Logan 1925).

The Blue Ledge re-opened in 1930 following its lease to a Dr. J.F. Reddy of Medford, Oregon and a George Hughes of Spokane, WA. Obtained largely by sorting the ore dump, 2,575 tons of good-grade ore were shipped (Hundhausen 1947). The mine's ownership history in the subsequent years remains murky. California mining reports credit ownership of the Blue Ledge to Towne Mines, Inc. in 1935 (Averill 1935), CMM in 1944 (Maxson 1948), and the Mexican Mining and Refining Company in 1947 (O'Brien 1947). During these years, limited exploration of the mine was conducted as well as a U.S. Bureau of Mines study that involved some sampling and drilling. The Bureau of Mines report cited D.C. Brown, of the Towne Securities Corporation, as the representative of the owners (Hundhausen 1947). In 1956, Transcontinental Resources purchased the mine and in 1974 Blue Ledge was sold to Michelle Tracey, a trustee for the Michelle E. Tracey Trust. Blue Ledge was leased in 1981 to Freeport Exploration, which performed soil surveys and 13,461 feet of rotary drilling. The mine was joint-ventured to Long Lac Mineral Exploration in 1984 for 9,588 feet of core drilling (Mattinen 1990). A Forest Service memo cites Sikaman Gold Resources of Toronto as the mine owner in August 1991 (Hamner 1998). A Forest Service correspondence, lists the Blue Ledge Corporation c/o Robert J. Custis, Esq. as owner in 1998. (Gladen 1998). The most recent reports place ownership of the mine back with Michelle E. Tracey, who is currently seeking its sale (Wayne L. Johnson Group 2002).

6.0 DAMAGES EXCLUDED FROM LIABILITY

Sections 11.24(b) and (c) of 43 C.F.R. Part 11 require trustees following the CERCLA natural resource damage regulations to consider whether or not damages are excluded from liability under CERCLA and the Clean Water Act (CWA). This section presents an analysis of the applicability of such exclusions from liability.

6.1 Irreversible and Irretrievable Commitment of Resources Identified in an Environmental Impact Statement

CERCLA creates an exclusion from natural resource damage liability for damages resulting from releases that were specifically identified as an irreversible and irretrievable commitment of natural resources in an environmental impact statement (EIS) or comparable environmental analysis. The Forest Service is unaware of any EIS or comparable environmental analysis in which the damages of the sort that flow from documented injuries and potential injuries to natural resources are analyzed and identified as an irreversible and irretrievable commitment of natural resources. As a result, this exclusion from liability does not apply.

6.2 Releases and Damages Occurring Wholly Before 1980

CERCLA excludes from liability those situations in which *both* releases of hazardous substances and damages occurred wholly before 1980. Thus, if *either* some releases *or* some damages occur after 1980, the exclusion does not apply. This exclusion from liability does not apply to this matter because the site fails both prongs of the test necessary to qualify.

First, releases of hazardous substances from the Blue Ledge Mine began when the mine was first developed and have been continuous to the present day. Thus, releases have occurred after 1980.

Second, damages will be felt by the trustees after 1980. Damages under CERCLA mean the "monetary quantification stemming from an injury." Damages "occur" when a trustee monetizes the injury and incurs restoration expenses.[7] The trustees have not been aware of the nature and extent of the injury to aquatic and other natural resources in and around Joe Creek, Elliott Creek, and the Applegate Reservoir. Indeed, the Forest Service has undertaken this PAS to better understand whether or not injury to natural resources has occurred. In addition, neither the Forest Service nor any other trustee has monetized the value of such injuries resulting from the release of hazardous substances. Thus, damages have occurred after 1980.

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7 *See* In Re Acushnet River & New Bedford Harbor: Proceedings Re Alleged PCB Pollution, 716 F. Supp. 676, 679-683 (D. Mass. 1989); Aetna Casualty & Surety Co. v. Pintlar Corp., 948 F.2d 1507, 1515 (9th Cir. 1991); United States v. Asarco, Inc., No. CV 96-0122-N-EJL, 1999 U.S. Dist. LEXIS 18924, at *28–*29 (D. Idaho Sept. 30, 1999).

6.3 Damages Resulting from the Application of a Pesticide Product or Release of Recycled Oil

Damages resulting from an application of a pesticide product registered under the Federal Insecticide, Fungicide, and Rodenticide Act, 7 U.S.C. § 135-135k, and resulting from certain releases of recycled oil are excluded from liability. Releases from the Blue Ledge Mine Site do not involve pesticides or recycled oil. As a result, these exclusions are not triggered.

6.4 Federally Permitted Release

Federally permitted releases enumerated in Section 101(10) of CERCLA, 42 U.S.C. § 9601(10), are excluded from natural resource damage liability under CERLCA. There are eleven different types of permitted discharges on the list. To the Forest Service's knowledge, the Blue Ledge Mine site does not involve any such federally permitted releases.

6.5 Exclusions from Liability under the Clean Water Act Section 311

Releases fall within the exclusions from liability found under Section 311(a)(2) and Section (b)(3) of the CWA, 33 U.S.C. §§ 1321(a)(2) and 1321(b)(3), are also excluded from natural resource damage liability under CERCLA. These exceptions to liability largely deal with discharges permitted under the National Pollution Discharge Elimination System Program (NPDES permit), discharges permitted under international protocols, and discharges that, according to regulation, do not constitute "harmful" discharges. The releases from the Blue Ledge Mine Site do not fall within any of these exclusions from liability.

7.0 PRELIMINARY DETERMINATION REGARDING PREASSESSMENT SCREEN CRITERIA

43 C.F.R. § 11.2 (e) requires that a trustee preliminarily determine that five criteria set forth at 43 C.F.R. §11.2(e)(1)-(5) are met before proceeding with a natural resource damage assessment. The information and analysis presented in the preceding sections support a preliminary determination that such criteria are satisfied and that a natural resource damage assessment in conformity with the regulations can proceed.

Criterion 1. A release of a hazardous substance has occurred.

An understanding of geo-chemistry associated with the Blue Ledge Mine and AMD and water samples showing low pH at the mine and downstream of the mine, lead to the conclusion that sulfuric acid was and is being released from the Blue Ledge Mine and its associated waste piles. Similarly, water samples collected at and downstream of the mine document releases of metals characteristic of AMD including cadmium, copper, and zinc. Sulfuric acid, copper, cadmium, and zinc are CERCLA listed hazardous substances pursuant to 40 C.F.R. § 302.4.

Criterion 2. Natural resources for which the trustees may assert trusteeship under CERCLA have been or are likely to have been adversely affected by the release.

The Department of Agriculture, through the Forest Service, is a properly designated federal trustee for natural resources located on, over, and under national forest lands. This PAS documents that injury has occurred to resources under the trusteeship of the Forest Service associated with the Rogue River National Forest. Documented injuries include those to biological resources and aquatic resources of the Rogue River National Forest. The full nature and extent of this injury is not yet known. This PAS also documents that other resources under the trusteeship of the Forest Service are likely to have been adversely affected by the releases from the Blue Ledge Mine. Such natural resources potentially injured include, but are not limited to, injuries to geologic resources and terrestrial resources of the Rogue River National Forest.

Criterion 3. The quantity and concentration of the released hazardous substance is sufficient to potentially cause injury to natural resources.

Miles of adits and tons of waste rock have created a significant source of AMD, containing hazardous substances. Existing data document that the quantity and concentration of hazardous substances is sufficient to significantly lower the pH to make waters unsuitable for the survival of fish and benthics. In addition, releases of hazardous substances have produced concentrations of metals in excess of maximum contaminant levels set under the Safe Drinking Water Act (SDWA) in waters of the Rogue River National Forest. Moreover, metal concentrations are considered high enough to produce injury and death in fish and to seriously injure the benthic community in Joe Creek. In certain times of the year, as a result of releases of hazardous substances from the Blue Ledge Mine, the entire length of Joe Creek is devoid of benthics.

Releases of hazardous substances and transport of contaminated fine materials from the waste disposal areas at the mine has the potential to cause injuries in Elliott Creek and the Applegate River and Reservoir.

Criterion 4. Data sufficient to pursue an assessment are readily available or are likely to be obtained at a reasonable cost.

Readily available information has been assembled for this PAS. This information, the analysis contained in this PAS, and a body of literature on AMD and its deleterious effects on natural resources offer a strong basis to focus an assessment and obtain additional information at reasonable cost. There are no major impediments to the collection of samples likely to be useful in an assessment, including, but not limited to, water samples, sediment samples, and tissue samples. Additional information providing a base for a natural resource damage assessment can be collected without undue cost.

Criterion 5. Response actions carried out or planned do not or will not sufficiently remedy the injury to natural resources without further action.

The Blue Ledge Mine Site is a continuing source of AMD that has caused and will continue to cause natural resource injuries. No response actions have been undertaken nor are any planned by the US EPA or State of California for the site. Without further action, injured resources will not naturally restore themselves.

8.0 CONCLUSION

The five criteria set forth in the CERCLA regulations at 43 C.F.R. § 11.2 (e)(1)-(5) for proceeding with a natural resource damage assessment have been met for the Blue Ledge Mine Site. The low pH in water running through the 55,000-60,000 tons of waste rock and the mine workings indicates the release of sulfuric acid. Metal concentrations in the waters directly downstream of the Blue Ledge Mine, Joe Creek and Elliott Creek, indicate the release of cadmium, copper, and zinc. Although sediment sampling has not been conducted, the geology, geochemistry, and site conditions indicate likely sediment contamination in Joe and Elliott Creek, and maybe as far downstream as the Applegate Reservoir.

The waste left behind and the workings at the Blue Ledge Mine Site have released and continue to release hazardous substances listed under CERLCA – sulfuric acid and metals (copper, cadmium, and zinc) – typical of AMD. Water samples taken by the Forest Service document releases of hazardous substances from the Blue Ledge Mine in levels injurious to human health and aquatic resources. Exceedances of primary drinking water standards were observed for cadmium and copper and additional exceedances of secondary drinking water standards were observed for copper, iron and zinc. There have also been numerous exceedances of ALCs in Joe Creek and Elliott Creek, often concentrations were many times that of the standard.

The contaminants released from the Blue Ledge Mine are toxic to aquatic resources, such as fish and macroinvertebrates. The information collected to date indicates that this is the case downstream of Blue Ledge Mine, and survey data have shown that there are no fish in Joe Creek. Metal concentrations detected in Joe and Elliott Creeks are much higher than those found to result in adverse effects and high mortality rates in rainbow trout and other fish. In addition, metals data from Joe Creek indicate that the macroinvertebrate population in Joe Creek has been adversely impacted due to AMD releases from Blue Ledge Mine. Amphibian survey data are highly indicative of AMD effects on amphibian populations downstream of the Blue Ledge Mine. Various life stages of tailed frog (*Ascaphus truei*) and Pacific giant salamander (*Dicamptodon tenebrosus*) were found upstream of the mine in both surveys; however, no amphibians were counted at the JC4 site directly downstream of the mine and a maximum of only three was found at any site further downstream. Groundwater may also be impacted.

The Forest Service has preliminarily identified the areas in and around 1) Joe Creek, 2) Elliott Creek downstream of Joe Creek, 3) the Applegate River downstream of Elliott Creek, and 4) the Applegate Reservoir as areas where exposures to hazardous substances released from the Blue Ledge Mine can occur for the following reasons. First, it is likely that fines from the mine waste are transported via Joe Creek to Elliott Creek and to the Applegate Reservoir. Second, analyses of water samples taken in Elliott Creek upstream and downstream of the confluence with Joe Creek document that dissolved metals from the mine have been transported to Elliott Creek. Third, to the extent bioaccumulation of hazardous substances has occurred, natural resources that live in areas removed from these water-bodies could be affected. A continual source of AMD, the Blue Ledge Mine Site will continue to cause natural resource injuries.

The information used to develop this PAS provides a substantial base from which a full assessment can be performed at a reasonable cost.

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