

APPENDIX B
SCREENING-LEVEL HUMAN HEALTH RISK EVALUATION

Screening-Level Human Health Risk Evaluation

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Screening-Level Human Health Risk Evaluation

A screening-level human health risk evaluation (SL-HHRE) was conducted for four aquatic and aquatic-related environments downstream of the Blue Ledge Mine, including 1) Joe Creek, 2) Elliot Creek downstream of its confluence with Joe Creek, 3) a portion of the Middle Fork of the Applegate River between the mouth of Elliot Creek and Applegate Reservoir, and 4) the head of Applegate Reservoir (see Figure 3, SI Report). Forward-calculated risk estimates were obtained using generic human health screening levels from the literature, and in some cases, site-specific background levels obtained from upstream of Blue Ledge Mine. A sample point-by-point screening was conducted to take into account streamlined sample collection. See Tables B-1 through B-26, for details.

Conceptual Site Model of Human Exposure

Water passes through Blue Ledge Mine as surface water that flows over the top of and, to some extent, through the waste rock that forms a steep slope on the downgradient side of Blue Ledge Mine. At the base of the main waste rock slope there is a settling area known as the log dam. From this point, the water from Blue Ledge Mine enters Joe Creek. Joe Creek flows steeply down boulders and passes through plunge pools until its final 200 feet, where the grade is more level. Joe Creek enters Elliot Creek approximately 2 miles upstream of the confluence of Elliot Creek with the Middle Fork of Applegate River. The distance between this confluence and the head of Applegate Reservoir is approximately 1.5 river miles.

Mine water contaminants can be carried in dissolved form or on particulates suspended in the water column of surface water. In depositional areas such as creek areas of lower flow, some of these contaminants can settle into or become bound to bottom sediments. In locations where a creek or river bed turns sharply, and/or where areas of low flow exist, bottom sediments can be washed up into low-lying, riparian areas adjacent to the waterway. For the purposes of this assessment, it is assumed that soil samples collected from riparian areas represent floodplain material that was originally sediment and does not represent upland material that has migrated into the riparian area.

Based on previous investigations and knowledge of site history, six metals were identified as being contaminants of potential concern (COPCs) for humans: arsenic, cadmium, copper, iron, nickel, and zinc. However, because iron is an essential nutrient and is metabolically regulated by most organisms, including humans, it was considered to be a COPC in surface water only, but not a COPC in sediment, riparian soil, or fish tissue. Arsenic, cadmium, and lead are assumed to bioaccumulate, or increase in concentration as they pass up the food chain.

As stated in the Work Plan (URS 2008), potential exposure of human receptors to mine-related releases will be assumed to occur through ingestion of contaminants in fish tissue and direct contact with sediments and/or riparian soil. Direct contact with surface water, such as might occur with swimming, is assumed to be a minor exposure pathway. Based on information from a local resident, Mr. Luke Redecur (Pers. comm. 2008), and on searches for beneficial water use information conducted by URS, the small community of Joe Bar, located on Elliot Creek downstream of its confluence with Joe Creek, does not obtain drinking water from Elliot Creek.

Joe Creek flows from Blue Ledge Mine to its confluence with Elliot Creek through a canyon-like area. The majority of Joe Creek is very steep, comprised of large boulders and plunge pools, likely creating a physical barrier to fish passage. No fish were observed in Joe Creek during the June 2008 sampling event. Therefore, potential human health risks due to fish ingestion will be

assessed for Elliot Creek, the Middle Fork of Applegate River from the mouth of Elliot Creek to the head of Applegate Reservoir, and Applegate Reservoir.

Data Collection

In June of 2008, samples of surface water, sediment, riparian soil (soils from floodplain areas located within approximately 100 feet of the creek or river banks), and fish tissue were collected downstream of the Blue Ledge Mine site. Since no fish were found to be present in Joe Creek during the sampling event, no fish tissue samples were collected from Joe Creek. No riparian soil samples were collected from Applegate Reservoir.

Surface water, sediment, and riparian soil samples were also collected upstream of Blue Ledge Mine for use as site-specific background information. Surface water samples were collected from four tributaries of Joe Creek, including three unnamed tributaries and Manzanita Gulch (see Figure 5). Surface water samples were also collected near Blue Ledge Mine itself, including from two mine adits, the log dam at the downstream base of the Blue Ledge Mine waste rock slope, and two seeps observed in steep areas just downstream of Blue Ledge Mine.

In June 2008, reticulate sculpin (*Cottus perplexus*) were collected at three sampling locations in Elliot Creek and one sampling location in Applegate River downstream of the mouth of Elliot Creek using electrofishing protocols. Attempts to collect rainbow trout (*Oncorhynchus mykiss*) or bass species from among three Applegate Reservoir locations using electrofishing protocols were unsuccessful. Instead, one deceased rainbow trout was discovered in approximately five feet of water at the AR-02 location, and collected for tissue analysis. The fish did not show visible signs of decomposition, but it is unknown if its mortality was related to electrofishing. No fish were found to present in Joe Creek. No fish tissue samples were collected above the Blue Ledge Mine site, and thus no site-specific background concentrations of the six CPEC metals were calculated for fish tissue collected in Elliot Creek, the Middle Fork of the Applegate River between the mouth of Elliot Creek and the head of Applegate Reservoir, and the head of Applegate Reservoir.

Reticulate sculpin were selected as a species to be collected due to their ubiquity in Elliot Creek, their trophic niche as a bottom feeder, and their relative intransience within stream segments. Trout were targeted in the reservoir because they are a game species actively collected and consumed by the public and consequently have a direct link to human health.

During a survey of benthic invertebrates conducted in September 2008 for Joe Creek and Elliot Creek, a biologist performed a limited visual survey of the types of benthic invertebrates present (see Appendix F). Types and numbers of benthic invertebrates present help the surveyor to determine how good the water quality is likely to be. Certain types of benthic invertebrates such as caddisflies, mayflies, and in particular, stone flies typically indicate a high-water-quality stream with cooler water temperatures. Benthic invertebrates were visually surveyed and samples collected for in-lab identification from four locations. Sample locations and brief descriptions of what was observed at each are presented below:

- 1.) Joe Creek above (upstream of) the Blue Ledge Mine
Description: limited number of caddisflies and mayflies present. Water quality fairly good.
- 2.) Joe Creek below (downstream of) the main waste rock slope
Description: limited number of caddisflies and mayflies present; water quality not as good as above Blue Ledge Mine.
- 3.) Elliot Creek above the confluence of Joe Creek

Description: large numbers of caddisflies, mayflies, and stone flies. Water quality appeared to be very good.

4.) Elliot Creek below the confluence of Joe Creek

Description: large numbers of caddisflies, mayflies, and stone flies, but numbers not as high as those observed in Elliot Creek upstream of the confluence with Joe Creek. Water quality appeared to be good.

Data Evaluation

Data collected in June of 2008 were evaluated as part of this screening-level human health risk assessment. Data from earlier investigations were used to select COPCs, and the type and locations of samples that were collected in June and July of 2008. Earlier investigations are described in detail in the following documents:

- *Survey of Benthic Macroinvertebrates to Assess Effects of the Blue Ledge Mine on Aquatic Biota of Joe and Elliot Creeks, NW California.* Prepared by Michael S. Parker, PhD, Department of Biology, Southern Oregon University. September 2000.
- Joe Creek Level II Stream Survey. Siskiyou Research Group. October 2002.
- *Preassessment Screen for the Blue Ledge Mine Site.* Prepared by Environmental International Ltd. October 28, 2002.
- Preliminary Assessment/Site Inspection Report, Blue Ledge Mine. Prepared by Weston Solutions. April 28, 2004.
- *Technical Memorandum: Draft Preliminary Remediation Cost Estimates for the Blue Ledge Mine.* Prepared by Golder Associates. November 14, 2007.
- *Confidential Memorandum: Blue Ledge Mine Recreational Fishing and Natural Resource Damage Estimate.* To: Peter Jones, USDA Forest Service. From: Stratus Consulting, Inc. December 18, 2007.
- *Acid Mine Drainage and Assessment of Recent Remediation Efforts at the Blue Ledge Mine, Siskiyou County, California.* William S. Elliot, Jr; Jara A. Johnson; Marco A. Wikstrom; and Peter Jones. Department of Environmental Studies, Southern Oregon University. Undated.
- Geochemical Data for the Blue Ledge Mine. Tabulated data from Southern Oregon University, Dr. Bill Elliot. Undated.

Data collected in 2008 was analyzed for metals by Columbia Analytical Services Laboratory. Surface water samples were also analyzed for chemistry parameters including alkalinity, hardness, total dissolved solids (TDS), total suspended solids (TSS), and sulfate. Data validation, including a quality assurance/quality control review, was conducted by a URS chemist. The numbers and types of samples considered to be adequate for use in the risk assessment are listed in Table 1. Tabulated summaries of surface water, sediment, riparian soil, and fish tissue data are presented in Tables B-1, B-9, B-15, and B-21. Sample locations are shown in Figures 4 and 5.

As part of the Data Quality Objective process, human health criteria chosen as screening parameters in the SL-HHRE were used to identify acceptable media-specific analytical method reporting limits (MRLs) for the six metals being assessed prior to any sample analysis. In general, analytical MRLs should be lower than the related criteria that will be used to assess the related analytical data results, in order to determine whether chemicals are present at levels of concern. The only criterion which was exceeded by an analytical MRL was the EPA Region 6 human health medium-specific screening level (HHMSSL) for arsenic (0.045 micrograms per liter [ug/L]), which is based primarily on surface water being used as a drinking water source (USEPA 2007). Based on current information, surface water from Joe Creek and Elliot Creek are not used as sources of drinking water.

Identification of Site-Specific Background Levels of COPC Metals in Surface Water, Sediment, and Riparian Soil

Sample results used to calculate site-specific background concentrations were collected from above (i.e., upstream of) the Blue Ledge Mine site (Figure 5). Eight background surface water samples were collected: six from the two upstream creeks that converge just above Blue Ledge Mine, and two from two tributaries that flow into these creeks above Blue Ledge Mine. Metals data from these eight surface water samples were averaged and the resulting mean concentrations of the six metals were used as site-specific background concentrations for COPCs detected in surface water located downstream of Blue Ledge Mine.

Six background sediment samples were collected upstream of Blue Ledge Mine. As with the background surface water samples, the sediment metal concentrations were averaged and the resulting mean concentrations of the six metals were used as site-specific background concentrations for COPCs detected in sediment located downstream of Blue Ledge Mine.

Two background riparian soil samples were collected. Metals data from these two samples were averaged and the resulting mean concentrations for COPCs in upstream riparian soil were used as site-specific background concentrations for COPCs detected in riparian soil located downstream of Blue Ledge Mine. Site-specific background concentrations for metals detected in surface water, sediment, and riparian soil are presented in the tables for surface water, sediment, and riparian soil (Tables B-1, B-9, and B-15).

Since no fish were collected above the Blue Ledge Mine site, no site-specific background concentrations of the six COPC metals were calculated for fish tissue collected from Elliot Creek, the Middle Fork of the Applegate River between the mouth of Elliot Creek and the head of Applegate Reservoir, and the head of Applegate Reservoir.

Human Health Screening Criteria

The screening conducted here was used to determine whether concentrations of the six COPC metals in site media (i.e., surface water, sediment, riparian soil, and fish tissue) are present at concentrations that are potentially harmful to human receptors. For this streamlined screening, applicable screening criteria were used to evaluate which metals were present at concentrations that could potentially cause unacceptable risk to human receptors. The applicable criteria were protective of:

- 1) recreational users coming into contact with sediment,
- 2) residential human receptors coming into contact with riparian soils, and
- 3) recreational human fishers ingesting fish.

Since the site and its potentially affected downstream environments straddle the border between Oregon and California, criteria thought to be applicable in both states were compared to detected concentrations of COPC metals in site media.

In cases where site-specific background concentrations of a metal exceed available literature-based criteria, the site-specific background concentration will be used as the screening criterion. Where literature-based criteria exceed background, the most-stringent literature-based criterion that exceeds the site-specific background concentration will be used as the screening criterion.

In cases where no literature-based criteria are available, no screening of detected concentrations is possible. However, chemicals detected in media that have no applicable screening criteria must be assumed to be a potential human health problem, although risk estimates are not quantifiable in this situation. The primary example of metals without literature-based human health screening criteria involves cadmium, copper, iron, and lead detected in surface water. Although site-specific background concentrations in surface water are available for these four metals, basing a risk estimate on a background concentration alone, when no toxicity criteria have been made available, is not considered technically credible.

Please refer to Tables B-2, B-10, B-16, and B-22 for the criteria used to screen detected concentrations in each of the four media. These criteria are also presented below.

SURFACE WATER:

- California Water Quality Standards, human health criteria for ingestion of organisms only for Applegate River and Applegate Reservoir (USEPA 2000)
- Oregon Department of Environmental Quality Water Quality Standards, Tables 33A, 33B, and 33C, human health criteria for ingestion of organisms only for Applegate River and Applegate Reservoir (DEQ, 2004)
- USEPA 2006 National Recommended Water Quality Criteria. human health criteria for ingestion of organisms only for Applegate River and Applegate Reservoir (USEPA, 2006)

SEDIMENT:

- USEPA Region 6 human health medium-specific screening levels for residential soil (2007)
- California Regional Soil Levels (Bradford et al. 1996)

RIPARIAN SOIL:

- USEPA Region 6 human health medium-specific screening levels for residential soil (2007)
- California Regional Soil Levels (Bradford et al. 1996)

FISH TISSUE:

- DEQ Acceptable Tissue Levels (ATLs) in Fish/Shellfish Consumed by Humans (DEQ 2007). Note that no literature-based criteria are available to screen copper and zinc present in fish tissue.

As previously stated, a sample point-by-point screening was conducted. That is, no statistically representative exposure point concentrations were generated for the different water bodies being assessed. For each metal detected in each medium, the most stringent applicable criterion was chosen and used to generate carcinogenic and non-carcinogenic human health risk estimates at each sample point. In cases where a site-specific background concentration was higher than one or more of the applicable criteria, then the site-specific background concentration, rather than a criterion, was used to human health risk estimates for that metal in that medium.

In the case of background concentrations of riparian soil, site-specific background concentrations are based on the average of metals detected in two samples. The site-specific background concentrations of copper and zinc (approximately 56 mg/kg for both metals) were higher than one or more soil screening criteria, and so the background concentrations were used as the criteria with which corresponding risk estimate values were calculated.

When site-specific background concentrations are not available, California Regional Soil Levels (CRSLs) (Bradford et al., 1996) are often used as acceptable background levels for metals in soil. At Blue Ledge Mine, however, site-specific background concentrations were considered more representative of site conditions than the CRSLs. It is interesting to note that the site-specific riparian soil background concentrations calculated for arsenic, cadmium, lead, and zinc are all significantly lower than the CRSL values for these four metals. Only copper has a calculated site-specific riparian soil background concentration that is higher than its CRSL.

Acceptable levels of human health risk through exposure to a single carcinogenic compound cannot exceed a potential excess carcinogenic risk (PECR) level of 1.0E-06. Acceptable levels of human health risk associated with exposure to a single non-carcinogen cannot exceed a hazard quotient (HQ) of 1 (DEQ, 1998/2000). Estimates of PECRs from exposure to carcinogens (i.e., arsenic at this site) and HQs from exposure to non-carcinogens (zinc at this site) were generated using the simple proportional formulas presented below, and by solving for X in the equation.

For carcinogenic risk:

$$\frac{\text{Detected metal concentration}}{\text{Human health criterion}} = \frac{X}{1E-06}$$

Solving for X gives:

$$X = \frac{(\text{Detected metal concentration})}{(\text{Human health criterion})} * 0.000001$$

For noncarcinogenic risk:

$$\frac{\text{Detected metal concentration}}{\text{Human health criterion}} = \frac{X}{1.0}$$

Solving for X gives:

$$X = \frac{(\text{Detected metal concentration})}{(\text{Human health criterion})} * 1.0$$

Note that no estimates of non-carcinogenic risk associated with arsenic were made, since the criterion for the carcinogenic effects of arsenic are more stringent than those for the non-carcinogenic effects. Therefore, the discussion of potential human health risks related to arsenic are limited to carcinogenic effects only. Zinc has only been documented to have toxic, i.e., non-carcinogenic, effects.

Human Health Risk Estimates Based on Screening Criteria

Although screening risk estimates were calculated for each metal in each medium on a sample point-by-sample point basis, the results will be discussed here in terms of each of the media and water bodies assessed. Risk estimate values for each sample result were obtained using the simple formulas presented above and the most stringent applicable criterion identified in each medium.

Arsenic was the only metal present in media samples at concentrations that resulted in unacceptable human health risk (i.e., excess cancer risk estimates greater than 1.0E-06), with the single exception of the zinc concentration detected in water collected from Adit AD-01. Calculation of PECRs for arsenic and the HQ for zinc in surface water was based on comparison to ambient water quality criteria protective of humans ingesting organisms only, while calculation of PECRs for sediment and riparian soil was based on the site-specific average background concentrations in each of these media. No exceedances of human health criteria occurred in site media for cadmium, copper, iron, or lead. Because no literature-based criteria were available for human ingesting fish exposed to cadmium, copper, iron, or lead in surface water, no screening could be conducted for these four metals in surface water.

Groundwater Risk Estimates

Because groundwater exiting the adits and seeps immediately becomes surface water by definition, screening criteria used to assess metals in surface water were also used to assess metals in adits and seeps.

Adits and Seeps –

Two adit samples (AD-01 and AD-02), one dam sample, and two seep samples (SP-01 and SP-01) were collected just downslope/downstream of the Blue Ledge Mine. In these cases, groundwater was present at the surface. Surface water from both adits contained concentrations of arsenic that resulted in excess cancer risk estimates for arsenic of 2.6E-05 and 4.6E-05. The dam location and the two seeps did not contain arsenic at concentrations that resulted in unacceptable human health risk. Water collected from Adit AD-01 contained zinc at a concentration that resulted in a high HQ of 11.5.

Surface Water Risk Estimates

The screening criterion used to compare to detected concentrations of arsenic is meant to be protective of recreational anglers consuming fish exposed to surface water containing arsenic.

Joe Creek –

Seven surface water samples were collected from Joe Creek. None of the samples contained arsenic at concentrations that exceeded criteria.

Tributaries of Joe Creek downstream of Blue Ledge Mine –

Two surface water samples were collected from two different tributaries of Joe Creek downstream of the Blue Ledge Mine. Arsenic concentrations from T3 were non-detect at an analytical method reporting limit of 0.5 ug/L, a concentration which is higher than the screening criterion of 0.14 ug/L. The estimated cancer risk from arsenic present in surface water collected from the Mazanita Gulch tributary is 2.1E-06.

Elliot Creek –

Seven surface water samples were collected. Excess cancer risk estimates for arsenic range from 1.6E-06 at location EC-06 to 3.6E-06 at location EC-01.

Applegate River (between mouth of Elliot Creek and head of Applegate Reservoir) –

Two surface water samples were collected in Applegate River. Surface water collected from location AR-01 was non-detect for arsenic. At location AR-02, the excess cancer risk estimate for arsenic is 2.1E-06.

Applegate Reservoir -

Concentrations of metals detected in the single surface water sample collected at location ARV-04 resulted in an excess cancer risk estimate for arsenic of 2.6E-06.

Sediment Risk Estimates

The site-specific average background concentration of arsenic present in sediment samples located upstream of the Blue Ledge Mine was used as the screening criterion.

Joe Creek –

Five sediment samples were collected in Joe Creek. Excess cancer risk estimates for arsenic ranged from 2.0E-06 at location JC-01 to 2.8E-06 at location JC-04.

Elliot Creek –

Seven sediment samples were collected in Elliot Creek. Locations EC-06 and EC-07 were collected upstream of the confluence of Joe Creek with Elliot Creek (see Figure 4). Excess cancer risk estimates in the two upstream locations were 3.3E-06 and 5.1E-06, respectively. Excess cancer risk estimates for arsenic in sediment in Elliot Creek downstream of the confluence with Joe Creek range from 2.4E-06 at location EC-05 to 4.1E-06 at location EC-4.

Applegate River (between mouth of Elliot Creek and head of Applegate Reservoir) –

The two sediment samples collected from Applegate River have excess cancer risk estimates for arsenic of 2.6E-06 and 2.9E-06.

Applegate Reservoir -

The four sediment samples collected from Applegate Reservoir have excess cancer risk estimates ranging from 2.7E-06 to 3.2E-06.

Riparian Soil Risk Estimates

The site-specific average background concentration of arsenic present in two riparian samples collected upstream of the Blue Ledge Mine was used as the screening criterion.

Joe Creek –

Three riparian soil samples were collected adjacent to Joe Creek at locations JC-01, JC-03, and JC-04. These samples have excess cancer risk estimates for arsenic of 1.6E-06, 8.1E-06, and 2.2E-06, respectively.

Elliot Creek –

The four riparian soil samples collected adjacent to Elliot Creek have excess cancer risk estimates for arsenic ranging from 1.5E-06 to 2.7E-06.

Applegate River (between mouth of Elliot Creek and head of Applegate Reservoir) –

One riparian soil sample was collected adjacent to the Middle Fork of the Applegate River, between the mouth of Elliot Creek and the head of Applegate Reservoir. This sample has an associated excess cancer risk for arsenic of 2.1E-06.

Fish Tissue Risk Estimates

Although surface water criteria that were protective of humans ingesting fish/shellfish were used to screen surface water data, those criteria were based on how low the arsenic concentration has to be in surface water to avoid impacting fish/shellfish tissue at a level that would be dangerous to the humans eating them. However, because fish tissue samples were collected, a more direct comparison can be made to criteria that are protective of humans eating fish/shellfish tissue. A stringent human health criterion protective of recreational fishermen consuming fish and shellfish tissue (i.e., Acceptable Tissue Level [DEQ 2007]) was used to screen detected concentrations of arsenic in fish tissue.

Elliot Creek –

Three fish tissue samples were collected in Elliot Creek at locations EC-02, EC-04, and the location upstream of the confluence with Joe Creek, EC-07. These samples have excess cancer risk estimates for arsenic of 2.4E-05 for both downstream samples, and 3.9E-05 for the upstream sample.

Applegate River (between mouth of Elliot Creek and head of Applegate Reservoir) –

A single fish tissue sample and a duplicate sample were collected at location AR-02. These samples have an excess cancer risk estimate for arsenic of approximately 2.4E-05.

Applegate Reservoir -

The single fish tissue sample collected from Applegate Reservoir has an associated excess cancer risk estimate for arsenic of 2.3E-05.

Summary and Conclusions

Arsenic is the only metal that exceeded criteria protective of human health in any of the media sampled, with the exception of a single detection of zinc in water collected from Adit AD-01. Estimated PECRs for arsenic and the HQ for zinc in surface water were based on ambient water quality criteria protective of humans ingesting organisms only, while estimated PECRS for

arsenic in sediment and riparian soil were based on site-specific background concentrations, which were higher than at least one literature-based criterion.

Generally, it appears that the arsenic concentrations causing unacceptable risk human health risk are not associated with Joe Creek, but rather are typical of conditions in Elliot Creek. It is unclear at this time if arsenic is naturally-occurring, or originates from a source other than Joe Creek. As discussed above, acceptable PECR values cannot exceed a risk of 1.0E-06.

HUMAN HEALTH RISKS RELATED TO METALS DETECTED IN SURFACE WATER

Water collected from the two mine adits contained concentrations of arsenic that were high, resulting in unacceptable PECRs greater than 3E-05. Water collected from Adit AD-01 also contained zinc at a concentration resulting in an unacceptable HQ of 11.5. Arsenic was non-detect in water collected from Seep SP-02 and the dam location, and nearly non-detect in water collected from Seep SP-01. Arsenic was not detected in any of the surface water samples collected from Joe Creek. Surface water collected from tributary T3JC-01 did not contain detectable concentrations of arsenic, while surface water collected from the tributary referred to as Manzanita Gulch contained arsenic at a concentration resulting in an unacceptable PECR of 2.1E-06. Unacceptable PECRs related to Elliot Creek surface water were moderately high, and ranged from 1.6E-06 (location EC-06, upstream of confluence with Joe Creek) to 3.6E-06 (location EC-01). The single surface water sample collected in Applegate River contained arsenic at a concentration resulting in a unacceptable PECR of 2.1E-06, while the arsenic detected in the surface water sample collected from Applegate Reservoir resulted in a unacceptable PECR of 2.6E-06.

HUMAN HEALTH RISKS RELATED TO METALS DETECTED IN SEDIMENT

Arsenic detected in sediments collected from Joe Creek resulted in unacceptable but relatively low PECRs ranging from 1.7E-06 (location JC-08) to 2.8E-06 (location JC-04). Unacceptable PECR estimates for arsenic detected in Elliot Creek sediments ranged from 2.3E-06 (location EC-05) to 5.1E-06 (location EC-07, upstream of confluence with Joe Creek). Unacceptable PECR estimates for arsenic detected in Applegate River sediments were relatively low, ranging from 2.6E-06 to 2.9E-06. Unacceptable PECR estimates in Applegate Reservoir were a little higher than those in Applegate River, and ranged from 2.7E-06 to 3.2E-06.

HUMAN HEALTH RISKS RELATED TO METALS DETECTED IN RIPARIAN SOIL

Unacceptable PECR estimates for arsenic detected in riparian soils adjacent to Joe Creek at locations JC-01 and JC-04, in the five riparian soil samples collected adjacent to Elliot Creek, and the single riparian soil sample collected adjacent to Applegate River, are all similar and relatively low, ranging from 1.5E-06 to 2.7E-06. However, sample location JC-03 in Joe Creek had a relatively high estimated PECR of 8.1E-06..

HUMAN HEALTH RISKS RELATED TO METALS IN FISH TISSUE

Excess cancer risk estimates for fish tissue were relatively high in all water bodies samples (Elliot Creek, Applegate River, and Applegate Reservoir), ranging from 2.1E-05 up to 3.9E-05.

Suggested Risk-Based Human Health Cleanup Criteria

In each case where a detected concentration for arsenic results in an estimated excess cancer risk value that exceeds $1.0E-06$, a conservative cleanup criterion would be equal to the “most stringent criterion” identified. In the cases of surface water, sediment, and riparian soil, the background concentration of arsenic, rather than a regulatory criterion, was used as the most stringent screening criterion. In the case of fish tissue, the screening criterion is based on protection of recreational fishers who consume fish.

Concentrations of the most stringent criteria based on type of metal and type of medium can be found in the summary risk estimate tables for surface water, sediment, riparian soil, and fish tissue (Tables B-2, B-10, B-16, and B-21).

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Table B-1
Summary of Surface Water Data
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	General Chemistry Parameters - mg/L						Dissolved Metals - ug/L					
	Alkalinity	Hardness	TDS	TSS	Sulfate	Arsenic	Cadmium	Copper	Iron	Lead	Zinc	
Background												
T4JC-01-SW-08627-URS	12	11.5	24	5	U 1.0	0.07	U 0.008	U 0.86	4.0	U 0.035	1.90	
T4JC-02-SW-08627-URS	12	11.5	23	5	U 1.0	0.07	U 0.008	U 0.89	7.4	J 0.02	U 1.93	
JC-15-SW-080627-URS	26	23.9	18	5	U 2.5	0.07	U 0.008	U 0.74	4.0	U 0.02	U 0.92	
JC-14-SW-080627-URS	26	23.8	17	5	U 2.5	0.07	U 0.008	U 0.71	4.0	U 0.02	U 1.10	
JC-13-SW-080627-URS	25	24	29	5	U 2.5	0.07	U 0.008	U 0.84	4.0	U 0.02	U 0.82	
JC-12-SW-080627-URS	24	23.6	33	5	U 2.5	0.07	U 0.008	U 0.73	4.0	U 0.02	U 0.75	
JC-11-SW-080627-URS	25	23.8	14	5	U 2.5	0.08	J 0.008	U 0.75	4.0	U 0.02	U 0.49	
JC-10-SW-080627-URS	25	24.5	26	5	U 2.5	0.07	U 0.008	U 0.77	4.0	U 0.02	U 0.65	
Average	21.9	20.8	23.0	5.0	U 2.1	0.07	0.01	0.79	2.68 ^a	0.022	1.07	
Rivers and Creeks												
JC-09-SW-080627-URS	22	21.3	15	5	U 2.3	0.07	U 0.031	3.45	4.0	U 0.02	U 6.01	
JC-08-SW-080626-URS	21	20.6	21	5	U 2.8	0.07	U 0.228	29.0	4.0	U 0.043	U 42.9	
JC-07-SW-080626-URS	20	20.8	43	5	U 3.6	0.07	U 0.537	62.8	4.0	U 0.060	U 88.5	
JC-07-SW-DUP-080626-URS	22	20.9	15	5	U 3.6	0.07	U 0.519	62.4	4.0	U 0.066	U 87.6	
JC-04-SW-080627-URS	32	35	40	5	U 5.1	0.07	U 0.504	31.8	5.1	J 0.02	U 61.2	
JC-03-SW-080625-URS	31	36.4	55	5	U 5.1	0.07	U 0.496	34.9	4.0	U 0.02	U 63.7	
JC-02-SW-080625-URS	33	37.1	37	5	U 5.1	0.07	U 0.519	35.6	4.0	U 0.02	U 69.3	
JC-01-SW-080625-URS	35	37	48	5	U 5.1	0.07	U 0.564	31.3	4.0	U 0.02	U 79.4	
EC-07-SW-080625-URS	47	44.9	71	5	U 2.8	0.35	J 0.008	U 0.46	4.0	U 0.02	U 0.61	
EC-06-SW-080625-URS	38	40.4	73	5	U 3.1	0.22	J 0.180	13.9	4.0	U 0.02	U 22.3	
EC-05-SW-080625-URS	42	43.4	66	5	U 3.0	0.39	J 0.042	3.03	4.0	U 0.02	U 3.49	
EC-04-SW-080625-URS	42	44	64	5	U 3.0	0.37	0.040	3.22	4.0	U 0.02	U 3.82	
EC-04-SW-DUP-080625-URS	44	43.1	82	5	U 2.9	0.40	0.049	3.25	4.0	U 0.02	U 4.73	
EC-03-SW-080625-URS	41	44.3	76	5	U 3.0	0.31	J 0.046	3.22	4.0	U 0.02	U 4.38	
EC-02-SW-080625-URS	43	43.9	77	5	U 3.0	0.37	J 0.038	3.62	4.0	U 0.02	U 4.94	
EC-01-SW-080624-URS	40	42.3	81	5	U 3.0	0.50	J 0.049	7.82	6.0	J 0.023	3.95	
AR-01-SW-080624-URS	36	41.6	64	5	U 2.5	0.07	U 0.018	J 0.02	U 5.6	J 0.016	J 0.05	
AR-02-SW-080624-URS	38	41.1	50	5	U 1.9	0.29	J 0.025	1.61	4.6	J 0.008	J 2.15	
ARV-04-SW-080624-URS	42	39.3	77	5	U 1.8	0.37	J 0.012	J 1.89	7.9	J 0.011	J 2.2	
Tributaries												
T4JC-01-SW-08627-URS	12	11.5	24	5	U 1.0	0.07	U 0.008	U 0.86	4.0	U 0.035	1.90	
T4JC-02-SW-08627-URS	12	11.5	23	5	U 1.0	0.07	U 0.008	U 0.89	7.4	J 0.02	U 1.93	
T3JC-01-SW-080626	78	74.1	91	8	1.9	0.50	U 0.01	0.42	97.9	0.007	1.75	
MG-01-SW-080626-URS	77	82.2	120	5	U 9.0	0.29	J 0.008	U 0.51	22.4	0.020	U 1.13	
T2JC-01	Not Sampled - Tributary Dry											
T1JC-01	Not Sampled - Tributary Dry											
Adits and Seeps												
AD-01-080624-URS	2	U 576	5060	5	U 2770	3.19	70.9	194000	748000	8.640	300000	
AD-02-080624-URS	134	548	801	6	393	1.81	0.598	4.77	53.6	0.020	1200	
SP-01-080624-URS	31	31	23	5	U 5.7	0.10	J 0.839	65.9	20.3	0.210	132	
DAM-01-080624-URS	2	U 63.5	160	5	U 112	0.07	U 33.7	4680	1670	8.370	6180	
SP-02-080627-URS	22	36.8	81	5	U 18.3	0.07	U 5.450	699	4.0	U 0.219	913	

U - analyte was not detected at or above analytical method reporting limit.

J - estimated analytical value.

JC = Joe Creek.

EC = Elliott Creek.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

ARV = Applegate Reservoir.

T1, T2, T3 = tributaries to Joe Creek downstream of Blue Ledge Mine.

T4 = tributaries located upstream of Blue Ledge Mine.

MG = Manzanita Gulch (tributary to Joe Creek).

AD = mine adit.

Dam = dam location at based of waste rock pile adjacent to Blue Ledge Mine.

SP = seep

TDS = total dissolved solids.

TSS = total suspended solids.

a = average was obtained by halving the U-flagged values, summing the data including the estimated value of 7.4, and then dividing by eight.

Table B-2
Surface Water Human Health Criteria
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	General Chemistry Parameters - mg/L						Dissolved Metals - ug/L						
	Alkalinity	Hardness	TDS	TSS	Sulfate	Arsenic	Cadmium	Copper	Iron	Lead	Zinc		
Background													
Site-Specific Average	21.9	20.8	23.0	5.0	U	2.1	0.07	0.008	U	0.8	2.7	0.022	1.1
Screening Criteria													
CalWQS - humans ingesting organisms only	--	--	--	--	--	--	--	--	--	--	--	--	--
DEQ Tables 33A, 33B, and 33C AWQC - humans ingesting organisms only	20	--	--	--	--	0.14	--	--	--	--	--	--	26,000
EPA NRWQC - protective of humans ingesting organisms only	--	--	--	--	--	0.14	--	--	--	--	--	--	26,000
FINAL SCREENING CRITERION						0.14	NA	NA	NA	NA	NA	NA	26,000

-- indicates that no criterion is available.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

In cases where the background concentration is higher than a criterion or criteria, the background concentration is used as the final screening criterion.

TDS = total dissolved solids.

TSS = total suspended solids.

NA = no surface water criteria protective of human ingesting aquatic organisms are available.

CalWQS = California water quality standards for humans ingesting organisms only, Federal Register, Thursday, May 18, 2000. Part III. Environmental Protection Agency. 40 CFR Part 131 - Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule.

DEQ Tables 33A, 33B, and 33C AWQC - Human health: For consumption of organisms only = Tables 33A and 33B, Water Quality Criteria Summary, Oregon Administrative Rules, Chapter 340, Division 41 - Department of Environmental Quality. Oregon Environmental Quality Commission adopted these criteria on May 20, 2004. However, as of 8-25-08, EPA still has not approved the criteria.

EPA NRWQC = National Recommended Water Quality Criteria for Priority Toxic Pollutants. Protective of humans ingesting organisms only. USEPA, Office of Water, Office of Science and Technology, 2006. <http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf>.

**Table B-3
Screening of Surface Data for Adits and Seeps
Screening-Level Human Health Risk Assessment
Blue Ledge Mine**

Sample Name	General Chemistry Parameters - mg/L						Dissolved Metals - ug/L								
	Alkalinity	Hardness	TDS	TSS	Sulfate		Arsenic	Cadmium	Copper	Iron	Lead	Zinc			
Background															
Site-Specific Average	21.9	20.8	23.0	5.0	U	2.1	0.07	0.008	U	0.8	2.7	0.022	1.1		
Adits and Seeps															
AD-01-080624-URS	2	U	576	5060	5	U	2770	3.19	70.9	194000	748000	8.640	300000		
AD-02-080624-URS	134		548	801	6		393	1.81	0.598	4.77	53.6	0.020	1200		
SP-01-080624-URS	31		31	23	5	U	5.7	0.10	J	0.839	65.9	20.3	0.210	132	
DAM-01-080624-URS	2	U	63.5	160	5	U	112	0.07	U	33.7	4680	1670	8.370	6180	
SP-02-080627-URS	22		36.8	81	5	U	18.3	0.07	U	5.450	699	4.0	U	0.219	913
Screening Criteria															
CalWQS - humans ingesting organisms only	--	--	--	--	--	--	--	--	--	--	--	--	--		
DEQ Tables 33A, 33B, and 33C AWQC - humans ingesting organisms only	20	--	--	--	--	--	--	0.14	--	--	--	--	26,000		
EPA NRWQC - protective of humans ingesting organisms only	--	--	--	--	--	--	--	0.14	--	--	--	--	26,000		
FINAL SCREENING CRITERION								0.14	NA	NA	NA	NA	26,000		

-- indicates that no criterion is available.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

AD = mine adit.

Dam = dam location at based of waste rock pile adjacent to Blue Ledge Mine.

SP = seep

TDS = total dissolved solids.

TSS = total suspended solids.

NA = no surface water criteria protective of human ingesting aquatic organisms are available.

CalWQS = California water quality standards for humans ingesting organisms only, Federal Register, Thursday, May 18, 2000. Part III. Environmental Protection Agency. 40 CFR Part 131 - Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule.

DEQ Tables 33A, 33B, and 33C AWQC - Human health: For consumption of organisms only = Tables 33A and 33B, Water Quality Criteria Summary, Oregon Administrative Rules, Chapter 340, Division 41 - Department of Environmental Quality. Oregon Environmental Quality Commission adopted these criteria on May 20, 2004. However, as of 8-25-08, EPA still has not approved the criteria.

EPA NRWQC = National Recommended Water Quality Criteria for Priority Toxic Pollutants. Protective of humans ingesting organisms only. USEPA, Office of Water, Office of Science and Technology, 2006. <http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf>.

Table B-4
Screening of Surface Water Data for Tributaries to Joe Creek downstream of Blue Ledge Mine
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	General Chemistry Parameters - mg/L						Dissolved Metals - ug/L					
	Alkalinity	Hardness	TDS	TSS	Sulfate	Arsenic	Cadmium	Copper	Iron	Lead	Zinc	
Background												
Site-Specific Average	21.9	20.8	23.0	5.0 U	2.1	0.07	0.008 U	0.8	2.7	0.022	1.1	
Tributaries on Joe Creek downstream of Blue Ledge Mine												
T3JC-01-SW-080626	78	74.1	91	8	1.9	0.50 U	0.01	0.42	97.9	0.007	1.75	
MG-01-SW-080626-URS	77	82.2	120	5 U	9.0	0.29 J	0.008 U	0.51	22.4	0.020 U	1.13	
T2JC-01	Not Sampled - Tributary Dry											
T1JC-01	Not Sampled - Tributary Dry											
Screening Criteria												
CalWQS - humans ingesting organisms only	--	--	--	--	--	--	--	--	--	--	--	
DEQ Tables 33A, 33B, and 33C AWQC - humans ingesting organisms only	20 ^a	--	--	--	--	0.14	--	--	--	--	26,000	
EPA NRWQC - protective of humans ingesting organisms only	--	--	--	--	--	0.14	--	--	--	--	26,000	
FINAL SCREENING CRITERION						0.14	NA	NA	NA	NA	26,000	

-- indicates that no criterion is available.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

Highlighted detected concentrations exceed one or more screening level values. Bold numbers indicate the criteria that have been exceeded.

If more than one criterion are exceeded by the same detected concentrations, then both criteria are bolded.

T1, T2, T3 = tributaries to Joe Creek downstream of Blue Ledge Mine.

MG = Mazanita Gulch tributary.

TDS = total dissolved solids.

TSS = total suspended solids.

NA = no surface water criteria protective of human ingesting aquatic organisms are available.

CalWQS = California water quality standards for humans ingesting organisms only, Federal Register, Thursday, May 18, 2000. Part III. Environmental Protection Agency. 40 CFR Part 131 - Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule.

DEQ Tables 33A, 33B, and 33C AWQC - Human health: For consumption of organisms only = Tables 33A and 33B, Water Quality Criteria Summary, Oregon Administrative Rules, Chapter 340, Division 41 - Department of Environmental Quality. Oregon Environmental Quality Commission adopted these criteria on May 20, 2004. However, as of 8-25-08, EPA still has not approved the criteria.

EPA NRWQC = National Recommended Water Quality Criteria for Priority Toxic Pollutants. Protective of humans ingesting organisms only. USEPA, Office of Water, Office of Science and Technology, 2006. <http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf>.

**Table B-5
Screening of Surface Water Data for Joe Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine**

Sample Name	General Chemistry Parameters - mg/L						Dissolved Metals - ug/L								
	Alkalinity	Hardness	TDS	TSS	Sulfate		Arsenic	Cadmium	Copper	Iron	Lead	Zinc			
Background (upstream of Blue Ledge Mine)															
Site-Specific Average	21.9	20.8	23.0	5.0	U	2.1	0.07	0.008	U	0.8	2.7	0.022	1.1		
Joe Creek downstream of Blue Ledge Mine															
JC-09-SW-080627-URS	22	21.3	15	5	U	2.3	0.07	U	0.031	3.45	4.0	U	0.02	U	6.01
JC-08-SW-080626-URS	21	20.6	21	5	U	2.8	0.07	U	0.228	29.0	4.0	U	0.043		42.9
JC-07-SW-080626-URS	20	20.8	43	5	U	3.6	0.07	U	0.537	62.8	4.0	U	0.060		88.5
JC-07-SW-DUP-080626-URS	22	20.9	15	5	U	3.6	0.07	U	0.519	62.4	4.0	U	0.066		87.6
JC-04-SW-080627-URS	32	35	40	5	U	5.1	0.07	U	0.504	31.8	5.1	J	0.02	U	61.2
JC-03-SW-080625-URS	31	36.4	55	5	U	5.1	0.07	U	0.496	34.9	4.0	U	0.02	U	63.7
JC-02-SW-080625-URS	33	37.1	37	5	U	5.1	0.07	U	0.519	35.6	4.0	U	0.02	U	69.3
JC-01-SW-080625-URS	35	37	48	5	U	5.1	0.07	U	0.564	31.3	4.0	U	0.02	U	79.4
Screening Criteria															
CalWQS - humans ingesting organisms only	--	--	--	--		--	--		--		--		--		--
DEQ Tables 33A, 33B, and 33C AWQC - humans ingesting organisms only	20 ^a	--	--	--		--	0.14		--		--		--		26,000
EPA NRWQC - protective of humans ingesting organisms only	--	--	--	--		--	0.14		--		--		--		26,000
FINAL SCREENING CRITERION							0.14		NA		NA		NA		26,000

-- indicates that no criterion is available.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

Highlighted detected concentrations exceed one or more screening level values. Bold numbers indicate the criteria that have been exceeded.

If more than one criterion are exceeded by the same detected concentrations, then both criteria are bolded.

TDS = total dissolved solids.

TSS = total suspended solids.

NA = no surface water criteria protective of human ingesting aquatic organisms are available.

CalWQS = California water quality standards for humans ingesting organisms only, Federal Register, Thursday, May 18, 2000. Part III. Environmental Protection Agency. 40 CFR Part 131 - Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule.

DEQ Tables 33A, 33B, and 33C AWQC - Human health: For consumption of organisms only = Tables 33A and 33B, Water Quality Criteria Summary, Oregon Administrative Rules, Chapter 340, Division 41 - Department of Environmental Quality. Oregon Environmental Quality Commission adopted these criteria on May 20, 2004. However, as of 8-25-08, EPA still has not approved the criteria.

EPA NRWQC = National Recommended Water Quality Criteria for Priority Toxic Pollutants. Protective of humans ingesting organisms only. USEPA, Office of Water, Office of Science and Technology, 2006. <http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf>.

Table B-6
Screening of Surface Water Data for Elliott Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	General Chemistry Parameters - mg/L							Dissolved Metals - ug/L								
	Alkalinity	Hardness	TDS	TSS	Sulfate	Arsenic	Cadmium	Copper	Iron	Lead	Zinc					
Site-Specific Background Average (upstream of Blue Ledge Mine)	21.9	20.8	23.0	5.0	U	2.1	0.07	0.008	U	0.8	2.7	0.022	1.1			
Elliott Creek																
EC-07-SW-080625-URS	47	44.9	71	5	U	2.8	0.35	J	0.008	U	0.46	4.0	U	0.02	U	0.61
EC-06-SW-080625-URS	38	40.4	73	5	U	3.1	0.22	J	0.180		13.9	4.0	U	0.02	U	22.3
EC-05-SW-080625-URS	42	43.4	66	5	U	3.0	0.39	J	0.042		3.03	4.0	U	0.02	U	3.49
EC-04-SW-080625-URS	42	44	64	5	U	3.0	0.37		0.040		3.22	4.0	U	0.02	U	3.82
EC-04-SW-DUP-080625-URS	44	43.1	82	5	U	2.9	0.40		0.049		3.25	4.0	U	0.02	U	4.73
EC-03-SW-080625-URS	41	44.3	76	5	U	3.0	0.31	J	0.046		3.22	4.0	U	0.02	U	4.38
EC-02-SW-080625-URS	43	43.9	77	5	U	3.0	0.37	J	0.038		3.62	4.0	U	0.02	U	4.94
EC-01-SW-080624-URS	40	42.3	81	5	U	3.0	0.50	J	0.049		7.82	6.0	J	0.023		3.95
Screening Criteria																
CalWQS - humans ingesting organisms only	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DEQ Tables 33A, 33B, and 33C AWQC - humans ingesting organisms only	20 ^a	--	--	--	--	--	0.14	--	--	--	--	--	--	--	26,000	
EPA NRWQC - protective of humans ingesting organisms only	--	--	--	--	--	--	0.14	--	--	--	--	--	--	--	26,000	
FINAL SCREENING CRITERION							0.14	NA	NA	NA	NA	NA	NA	26,000		

-- indicates that no criterion is available.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

Highlighted detected concentrations exceed one or more screening level values. Bold numbers indicate the criteria that have been exceeded.

If more than one criterion are exceeded by the same detected concentrations, then both criteria are bolded.

TDS = total dissolved solids.

TSS = total suspended solids.

NA = no surface water criteria protective of human ingesting aquatic organisms are available.

CalWQS = California water quality standards for humans ingesting organisms only, Federal Register, Thursday, May 18, 2000. Part III. Environmental Protection Agency. 40 CFR Part 131 - Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule.

Environmental Quality Commission adopted these criteria on May 20, 2004. However, as of 8-25-08, EPA still has not approved the criteria.

EPA NRWQC = National Recommended Water Quality Criteria for Priority Toxic Pollutants. Protective of humans ingesting organisms only. USEPA, Office of Water, Office of Science and Technology, 2006. <http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf>.

Table B-7
Screening of Surface Water Data for Applegate River from its confluence with Elliott Creek to Applegate Reservoir, and Applegate Reservoir
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	General Chemistry Parameters - mg/L						Dissolved Metals - ug/L												
	Alkalinity	Hardness	TDS	TSS	Sulfate	Arsenic	Cadmium	Copper	Iron	Lead	Zinc								
Background																			
Site-Specific Average	21.9	20.8	23.0	5.0	U	2.1	0.07	0.008	U	0.8	2.7	0.022	1.1						
Applegate River downstream of its confluence with Elliott Creek, and Applegate Reservoir																			
AR-01-SW-080624-URS	36	41.6	64	5	U	2.5	0.07	U	0.018	J	0.02	U	5.6	J	0.016	J	0.05	U	
AR-02-SW-080624-URS	38	41.1	50	5	U	1.9	0.29	J	0.025	J	1.61	J	4.6	J	0.008	J	2.15	J	
ARV-04-SW-080624-URS	42	39.3	77	5	U	1.8	0.37	J	0.012	J	1.89	J	7.9	J	0.011	J	2.2	J	
Screening Criteria																			
CalWQS - humans ingesting organisms only	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
DEQ Tables 33A, 33B, and 33C AWQC - humans ingesting organisms only	29 ^a	--	--	--	--	--	0.14	--	--	--	--	--	--	--	--	--	26,000	--	--
EPA NRWQC - protective of humans ingesting organisms only	--	--	--	--	--	--	0.14	--	--	--	--	--	--	--	--	--	26,000	--	--
FINAL SCREENING CRITERION							0.14	NA	26,000	NA	NA								

-- indicates that no criterion is available.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

Highlighted detected concentrations exceed one or more screening level values. Bold numbers indicate the criteria that have been exceeded.

If more than one criterion are exceeded by the same detected concentrations, then both criteria are bolded.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

ARV = Applegate Reservoir.

TDS = total dissolved solids.

TSS = total suspended solids.

NA = no surface water criteria protective of human ingesting aquatic organisms are available.

CalWQS = California water quality standards for humans ingesting organisms only, Federal Register, Thursday, May 18, 2000. Part III. Environmental Protection Agency. 40 CFR Part 131 - Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule.

Oregon Environmental Quality Commission adopted these criteria on May 20, 2004. However, as of 8-25-08, EPA still has not approved the criteria.

EPA NRWQC = National Recommended Water Quality Criteria for Priority Toxic Pollutants. Protective of humans ingesting organisms only. USEPA, Office of Water, Office of Science and Technology, 2006.

<http://www.epa.gov/waterscience/criteria/nrwqc-2006.pdf>.

Table B-8
Estimated Potential Excess Cancer Risk Estimates for
Surface Water Data
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic ^a		Potential Excess Cancer Risk	Zinc ^b	Non-Carcinogenic Hazard Quotient
Adits and Seeps					
AD-01-080624-URS	3.19		2.3E-05	300,000	11.5
AD-02-080624-URS	1.81		1.3E-05	1200	0.05
SP-01-080624-URS	0.10	J	7.1E-07	132	0.005
DAM-01-080624-URS	0.07	U	NA	6180	0.2
SP-02-080627-URS	0.07	U	NA	913	0.04
FINAL SCREENING CRITERION	0.14			26,000	
Tributaries of Joe Creek, downstream of Blue Ledge Mine					
T3JC-01-SW-080626	0.50	U	NA	NE	NA
MG-01-SW-080626-URS	0.29	J	2.1E-06	NE	NA
FINAL SCREENING CRITERION	0.14				
Elliott Creek					
EC-07-SW-080625-URS	0.35	J	2.5E-06	NE	NA
EC-06-SW-080625-URS	0.22	J	1.6E-06	NE	NA
EC-05-SW-080625-URS	0.39	J	2.8E-06	NE	NA
EC-04-SW-080625-URS	0.37		2.6E-06	NE	NA
EC-04-SW-DUP-080625-URS	0.40		2.9E-06	NE	NA
EC-03-SW-080625-URS	0.31	J	2.2E-06	NE	NA
EC-02-SW-080625-URS	0.37	J	2.6E-06	NE	NA
EC-01-SW-080624-URS	0.50	J	3.6E-06	NE	NA
FINAL SCREENING CRITERION	0.14				
Applegate River downstream of its confluence with Elliott Creek, and Applegate Reservoir					
AR-01-SW-080624-URS	0.07	U	NA	NE	NA
AR-02-SW-080624-URS	0.29	J	2.1E-06	NE	NA
ARV-04-SW-080624-URS	0.37	J	2.6E-06	NE	NA
FINAL SCREENING CRITERION	0.14				

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

NE = no exceedances of criterion, so detected concentrations not shown here.

NA = not applicable.

EC = Elliott Creek.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

ARV = Applegate Reservoir.

T3 = tributary 3 on Joe Creek downstream of Blue Ledge Mine.

MG = Manzanita Gulch (tributary of Joe Creek).

AD = mine adit.

Dam = dam location at base of waste rock pile adjacent to Blue Ledge Mine.

SP = seep

Highlighted detected concentrations exceed the most stringent criterion. Bold numbers indicate the excess cancer risk exceeding 1E-06.

Bold numbers indicate Excess Carcinogenic Risks that exceed 1.0E-06.

^a = Arsenic is a carcinogen. Criteria for arsenic are based on protection of human receptors at a PECR of 1.0E-06. Detected values shown represent dissolved concentrations of arsenic.

^b = Zinc is a non-carcinogen. A hazard quotient estimate that exceeds 1.0 indicates unacceptable human health risk.

There were no exceedances of criteria for any metal detected in Joe Creek surface water.

Highlighted results exceed one or more screening level values.

Table B-9
Summary of Sediment Data
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	% solids	Arsenic	Cadmium	Copper	Lead	Zinc
Background						
JC-15-SD-080627-URS	85.1	1.43	0.121	47.2	1.63	44.1
JC-14-SD-080627-URS	88.5	0.74	0.093	34.4	1.20	26.9
JC-13-SD-080627-URS	84.4	1.19	0.113	37.7	1.63	40.2
JC-12-SD-080627-URS	87.6	1.77	0.097	39.0	2.09 J	35.4
JC-11-SD-080627-URS	83.9	1.36	0.139	47.5	1.49	36.6
JC-10-SD-080627-URS	61.4	2.68	0.214	51.7	2.67	55.6
Average	81.8	1.5	0.13	42.9	1.8	39.8
Rivers and Creeks						
JC-08-SD-080627-URS	79.2	2.54 J	0.941	978	13.8	208
JC-06	Not sampled					
JC-05	Not sampled					
JC-04-SD-080627-URS	86.9	4.27	2.93	558	10.0	317
JC-03-SD-080626-URS	92.3	3.22	2.70	386	7.72	423
JC-02-SD-080626-URS	94.3	1.14	2.80	536	6.27	533
JC-01-SD-080626-URS	86.1	3.01	2.14	430	5.85	440
EC-08	Not sampled					
EC-07-SD-080625-URS	75.6	7.59	0.281	28.0	6.91	59.0
EC-06-SD-080625-URS	74.5	4.92	0.581	119	10.4	114
EC-05-SD-080625-URS	82.1	3.50	0.213	38.5	4.07	74.5
EC-05-SD-DUP-080625-URS	80.9	3.61	0.260	47.0	3.54	77.8
EC-04-SD-080625-URS	89.9	6.20	0.211	39.9	5.52	77.1
EC-04-SD-DUP-080625-URS	83.1	5.20	0.270	51.3	4.72	75.1
EC-03-SD-080625-URS	86.3	4.35	0.528	42.9	4.52	72.7
EC-02-SD-080625-URS	74.2	4.04	0.315	57.5	5.72	109
EC-01-SD-080624-URS	85.8	4.23	0.388	43.1	5.14	75.8
AR-01-SD-080624-URS	73.3	3.95	0.416	68.8	5.97	120
AR-02-SD-080624-URS	89.0	4.36	0.406	62.7	4.94	107
ARV-01-SD-080624-URS	72.6	4.76	0.422	70.8	6.54	111
ARV-02-SD-080624-URS	64.7	4.77	0.519	81.8	6.34	128
ARV-03-SD-080624-URS	46.9	4.71	0.572	107	8.24	116
ARV-04-SD-080624-URS	60.3	3.98	0.434	73.8	6.37	93.1

All results are in mg/kg on a dry weight basis unless otherwise noted.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

JC = Joe Creek.

EC = Elliott Creek.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

ARV = Applegate Reservoir.

TDS = total dissolved solids.

TSS = total soluble solids.

Table B-10
Human Health Criteria for Sediment
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background (Sediments located upstream of Blue Ledge Mine)					
Site-Specific Average	1.5	0.13	42.9	1.8	39.8
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Screening Criteria					
EPA R6 HHMSSLs	0.39^b	39	2,900	400	23,000
FINAL SCREENING CRITERION	1.5^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

^a Because site-specific background concentrations are available for sediment, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the final screening criterion. The EPA R6 HHMSSL value is less than the background concentration, and is identified as such by strikethrough font.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08. http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. Background Concentrations of Trace and Major Elements in California Soils. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-11
Screening of Sediment Data for Joe Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background					
Site-Specific Average	1.5 ^b	0.13	42.9	1.8	39.8
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Joe Creek					
JC-08-SD-080627-URS	2.54	J 0.941	978	13.8	208
JC-04-SD-080627-URS	4.27	2.93	558	10.0	317
JC-03-SD-080626-URS	3.22	2.70	386	7.72	423
JC-02-SD-080626-URS	1.14	2.80	536	6.27	533
JC-01-SD-080626-URS	3.01	2.14	430	5.85	440
Screening Criteria					
EPA R6 HHMSSLs	0.39 ^d	39	2,900	400	23,000
FINAL SCREENING CRITERION	1.5^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

Highlighted detected concentrations exceed one or more screening level values.

Detected concentrations that exceed the average background concentration are yellow-highlighted.

If more than one criterion is exceeded by different detected concentrations, a different color is assigned to each criterion exceeded.

^a Because site-specific background concentrations are available for sediment, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the most stringent criterion. The EPA R6 HHMSSL value is less than the background concentration, and is identified as such by strikethrough font.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08. http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. Background Concentrations of Trace and Major Elements in California Soils. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-12
Screening of Sediment Data for Elliott Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background					
Site-Specific Average	1.5 ^b	0.13	42.9	1.8	39.8
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Elliott Creek					
EC-07-SD-080625-URS	7.59	0.281	28.0	6.91	59.0
EC-06-SD-080625-URS	4.92	0.581	119	10.4	114
EC-05-SD-080625-URS	3.50	0.213	38.5	4.07	74.5
EC-05-SD-DUP-080625-URS	3.61	0.260	47.0	3.54	77.8
EC-04-SD-080625-URS	6.20	0.211	39.9	5.52	77.1
EC-04-SD-DUP-080625-URS	5.20	0.270	51.3	4.72	75.1
EC-03-SD-080625-URS	4.35	0.528	42.9	4.52	72.7
EC-02-SD-080625-URS	4.04	0.315	57.5	5.72	109
EC-01-SD-080624-URS	4.23	0.388	43.1	5.14	75.8
Screening Criteria					
EPA R6 HHMSSLs	0.39 ^d	39	2,900	400	23,000
FINAL SCREENING CRITERION	1.5^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

Detected concentrations that exceed the average background concentration are yellow-highlighted.

^a Because site-specific background concentrations are available for sediment, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the final screening criterion. The EPA R6 HHMSSL value is less than the background concentration, and is identified as such by strikethrough font.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08. http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. Background Concentrations of Trace and Major Elements in California Soils. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-13
Screening of Sediment Data for Applegate River downstream of its confluence with Elliot Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background					
Site-Specific Average	1.5 ^b	0.13	42.9	1.8	39.8
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Applegate River downstream of its confluence with Elliott Creek, and Applegate Reservoir					
AR-01-SD-080624-URS	3.95	0.416	68.8	5.97	120
AR-02-SD-080624-URS	4.36	0.406	62.7	4.94	107
ARV-01-SD-080624-URS	4.76	0.422	70.8	6.54	111
ARV-02-SD-080624-URS	4.77	0.519	81.8	6.34	128
ARV-03-SD-080624-URS	4.71	0.572	107	8.24	116
ARV-04-SD-080624-URS	3.98	0.434	73.8	6.37	93.1
Screening Criteria					
EPA R6 HHMSSLs	0.39 ^b	39	2,900	400	23,000
FINAL SCREENING CRITERION	1.5^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

Highlighted detected concentrations exceed one or more screening level values.

AR = Applegate River downstream of confluence with Elliott Creek.

ARV = Applegate Reservoir.

^a Because site-specific background concentrations are available for sediment, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the most stringent criterion. The EPA R6 HHMSSL value is less than the background concentration, and is identified as such by strikethrough font.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08. http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. Background Concentrations of Trace and Major Elements in California Soils. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-14
Estimated Potential Excess Health Cancer Risk for
Sediment Data
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic ^a		Potential Excess Cancer Risk
Joe Creek			
JC-08-SD-080627-URS	2.54	J	1.7E-06
JC-04-SD-080627-URS	4.27		2.8E-06
JC-03-SD-080626-URS	3.22		2.1E-06
JC-02-SD-080626-URS	1.14		7.6E-07
JC-01-SD-080626-URS	3.01		2.0E-06
FINAL SCREENING CRITERION	1.5		
Elliott Creek			
EC-08			
EC-07-SD-080625-URS	7.59		5.1E-06
EC-06-SD-080625-URS	4.92		3.3E-06
EC-05-SD-080625-URS	3.50		2.3E-06
EC-05-SD-DUP-080625-URS	3.61		2.4E-06
EC-04-SD-080625-URS	6.20		4.1E-06
EC-04-SD-DUP-080625-URS	5.20		3.5E-06
EC-03-SD-080625-URS	4.35		2.9E-06
EC-02-SD-080625-URS	4.04		2.7E-06
EC-01-SD-080624-URS	4.23		2.8E-06
FINAL SCREENING CRITERION	1.5		
Applegate River downstream of its confluence with Elliot Creek, and Applegate Reservoir			
AR-01-SD-080624-URS	3.95		2.6E-06
AR-02-SD-080624-URS	4.36		2.9E-06
ARV-01-SD-080624-URS	4.76		3.2E-06
ARV-02-SD-080624-URS	4.77		3.2E-06
ARV-03-SD-080624-URS	4.71		3.1E-06
ARV-04-SD-080624-URS	3.98		2.7E-06
FINAL SCREENING CRITERION	1.5		

J - estimated analytical concentration.

JC = Joe Creek.

EC = Elliott Creek.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

ARV = Applegate Reservoir.

Highlighted detected concentrations exceed the final screening criterion. Bold numbers indicate the criteria which were exceeded.

Bold numbers indicate Excess Carcinogenic Risks that exceed 1.0E-06.

^a The only metal detected at concentrations that exceeded criteria is arsenic. The background concentration, rather than a criterion, was used to calculate HQ values. Arsenic is a carcinogen. Since criteria for arsenic are based on protection of human receptors at 1.0E-06, background concentrations will be treated as if they are protective to this level.

Table B-15
Summary of Riparian Soil Data
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background					
JC-14-RS-080627-URS	1.24	0.092	45.2	1.83	38.9
JC-12-RS-080627-URS	3.16	0.166	67.1	5.29	73.1
Site-Specific Average	2.2	0.13	56.2	3.6	56.0
Rivers and Creeks					
JC-06	Not sampled				
JC-05	Not sampled				
JC-04-RS-080627-URS	3.44	0.354	204	15.1	86.7
JC-03-RS-080626-URS	17.8	0.202	141	11.6	119
JC-01-RS-080626-URS	4.73	1.09	378	31.2	172
EC-08	Not sampled				
EC-07-RS-080625-URS	5.84	0.220	51.9	6.08	84.6
EC-05-RS-080625-URS	5.37	0.281	60.4	6.37	74.0
EC-05-RS-DUP-080625-URS	5.01	0.311	80.0	6.17	74.0
EC-02-RS-080625-URS	3.29	0.191	56.0	5.75	64.9
EC-01-RS-080624-URS	5.61	0.324	74.1	5.99	97.9
AR-01-RS-080624-URS	4.65	0.654	85.0	7.06	185

All results are in mg/kg on a dry weight basis unless otherwise noted.

U - analyte was not detected at or above the analytical method reporting limit.

J - estimated analytical concentration.

JC = Joe Creek.

EC = Elliott Creek.

AR = Applegate River.

Table B-16
Human Health Criteria for Riparian Soil
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background based on two riparian soils samples adjacent to creek upstream of Blue Ledge Mine					
JC-14-RS-080627-URS	1.24	0.092	45.2	1.83	38.9
JC-12-RS-080627-URS	3.16	0.166	67.1	5.29	73.1
Site-Specific Average	2.2	0.13	56.2	3.6	56.0
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Screening Criteria					
EPA R6 HHMSSLs	0.39 ^b	39	2,900	400	23,000
FINAL SCREENING CRITERION	2.2^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

^a Because site-specific background concentrations are available for riparian soil, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the final screening criterion. Criterion lower than the background concentration is shown in strikethrough font.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08. http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. *Background Concentrations of Trace and Major Elements in California Soils*. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-17
Screening of Riparian Soil Data for Joe Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background (upstream of Blue Ledge Mine)					
Site-Specific Average	2.2 ^b	0.13	56.2	3.6	56.0
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Riparian Areas Adjacent to Joe Creek (downstream of Blue Ledge Mine)					
JC-06	Not sampled				
JC-05	Not sampled				
JC-04-RS-080627-URS	3.44	0.354	204	15.1	86.7
JC-03-RS-080626-URS	17.8	0.202	141	11.6	119
JC-01-RS-080626-URS	4.73	1.09	378	31.2	172
Screening Criteria					
EPA R6 HHMSSLs	0.39 ^b	39	2,900	400	23,000
FINAL SCREENING CRITERION	2.2^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

^a Because site-specific background concentrations are available for riparian soil, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the final screening criterion. Criterion lower than the background concentration is shown in strikethrough font.

Highlighted results exceed screening level value.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08.
http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. *Background Concentrations of Trace and Major Elements in California Soils*. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-18
Screening of Riparian Soil Data for Elliott Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background					
Site-Specific Average	2.2 ^b	0.13	56.2	3.6	56.0
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Riparian Areas Adjacent to Elliott Creek					
EC-07-RS-080625-URS	5.84	0.220	51.9	6.08	84.6
EC-05-RS-080625-URS	5.37	0.281	60.4	6.37	74.0
EC-05-RS-DUP-080625-URS	5.01	0.311	80.0	6.17	74.0
EC-02-RS-080625-URS	3.29	0.191	56.0	5.75	64.9
EC-01-RS-080624-URS	5.61	0.324	74.1	5.99	97.9
Screening Criteria					
EPA R6 HHMSSLs	0.39 ^b	39	2,900	400	23,000
FINAL SCREENING CRITERION	2.2^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

^a Because site-specific background concentrations are available for riparian soil, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the final screening criterion. Criterion lower than the background concentration is shown in strikethrough font.

Highlighted results exceed screening level value.

Bold background concentrations in combination with a criterion struck through indicates that average background concentration of metal is higher than indicated criterion. In this case, detected concentrations that exceed the average background concentration are yellow-highlighted.

If both the background concentration (that exceeds some criterion) and a 2nd criterion are exceeded by the same detected concentrations, then both the background concentration and the 2nd criterion, as well as the related detected concentrations, are yellow-highlighted.

If more than one criterion is exceeded by different detected concentrations, a different color is assigned to each criterion exceeded.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08.
http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996.
Background Concentrations of Trace and Major Elements in California Soils. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-19
Screening of Riparian Soil Data for Applegate River downstream of its confluence with Elliot Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Background					
Site-Specific Average	2.2 ^b	0.13	56.2	3.6	56.0
California Regional Soil Levels ^a	3.5	0.36	28.7	23.9	149
Riparian Soil Adjacent to Applegate River					
AR-01-RS-080624-URS	4.65	0.654	85.0	7.06	185
Screening Criteria					
EPA R6 HHMSSLs	0.39 ^b	39	2,900	400	23,000
FINAL SCREENING CRITERION	2.2^b	39	2,900	400	23,000

All results are in mg/kg on a dry weight basis unless otherwise noted.

Highlighted results exceed one or more screening level values.

^a Because site-specific background concentrations are available for riparian soil, the California Regional Soil Levels are presented here for informational purposes only.

^b Because the site-specific background concentration is greater than the HHMSSL criterion for arsenic, the site-specific background concentration is used as the final screening criterion. Criterion lower than the background concentration is shown in strikethrough font.

EPA R6 HHMSSLs = USEPA Region 6 Human Health Medium-Specific Screening Levels (for residential soil). December 2007, revised 3-8-08. http://www.epa.gov/Region06/6pd/rcra_c/pd-n/r6screenbackground.pdf.

California Regional Soil Levels -- Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. 1996. Background Concentrations of Trace and Major Elements in California Soils. Kearney Foundation of Soil Science, Division of Agriculture and Natural Resources, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

Table B-20
Estimated Potential Excess Human Health Cancer Risk for
Riparian Soil Data
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic ^a	Potential Excess Cancer Risk
Riparian Areas Adjacent to Joe Creek (downstream of Blue Ledge Mine)		
JC-04-RS-080627-URS	3.44	1.6E-06
JC-03-RS-080626-URS	17.8	8.1E-06
JC-01-RS-080626-URS	4.73	2.2E-06
FINAL SCREENING CRITERION	2.2	
Riparian Areas Adjacent to Elliott Creek		
EC-07-RS-080625-URS	5.84	2.7E-06
EC-05-RS-080625-URS	5.37	2.4E-06
EC-05-RS-DUP-080625-URS	5.01	2.3E-06
EC-02-RS-080625-URS	3.29	1.5E-06
EC-01-RS-080624-URS	5.61	2.6E-06
FINAL SCREENING CRITERION	2.2	
Riparian Soil Adjacent to Applegate River		
AR-01-RS-080624-URS	4.65	2.1E-06
FINAL SCREENING CRITERION	2.2	

All results are in mg/kg on a dry weight basis unless otherwise noted.

Highlighted detected concentrations exceed the final screening criterion. Bold numbers indicate the criteria which were exceeded.

Bold numbers indicate Excess Carcinogenic Risks that exceed 1.0E-06.

JC = Joe Creek.

EC = Elliott Creek.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

^a The only metal detected at concentrations that exceeded criteria is arsenic. The background concentration, rather than a criterion, was used to calculate HQ values. Arsenic is a carcinogen. Since criteria for arsenic are based on protection of human receptors at 1.0E-06, background concentrations will be treated as if they are protective to this level.

Table B-21
Summary of Fish Tissue Data
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
EC-07-FT-080626-URS	0.24	0.068	2.32	0.065	24.8
EC-04-FT-080626-URS	0.15	0.134	4.79	0.194	29.2
EC-02-FT-080626-URS	0.15	0.173	5.73	0.062	37.1
AR-02-FT-080627-URS	0.16	0.145	3.15	0.017	33.5
AR-02-FT-DUP-080627-URS	0.13	0.133	3.30	0.024	30.3
ARV-02-FT-080627-URS	0.14	0.049	2.29	0.027	22.9

Units are in milligrams per kilogram (mg/kg) - wet weight.

J - estimated analytical concentration.

JC = Joe Creek.

EC = Elliott Creek.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

ARV = Applegate Reservoir.

Table B-22
Human Health Criteria for Fish Tissue
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

	Arsenic	Cadmium	Copper	Lead	Zinc
Screening Criteria					
DEQ ATLS (mg/kg - wet wt)					
Human (Carcinogens General/Recreational)	0.0062	--	--	--	--
Human (Carcinogens Subsistence/Tribal)	0.00076	--	--	--	--
Human Non-carcinogens (General/Recreational)	1.2	4.0	--	0.5	--
Human Non-carcinogens (Subsistence/Tribal)	0.15	0.49	--	0.5	--
FINAL SCREENING CRITERION	0.0062	4	--	0.5	--

Units are in milligrams per kilogram (mg/kg) - wet weight.

-- Not available.

DEQ ATLS - Acceptable tissue levels (protective of humans ingesting fish/shellfish), *Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment*, Oregon Department of Environmental Quality Environmental Cleanup Program. January 31, 2007; updated April 3, 2007.

Table B-23
Screening of Fish Tissue Data for Elliott Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Elliott Creek					
EC-07-FT-080626-URS	0.24	0.068	2.32	0.065	24.8
EC-04-FT-080626-URS	0.15	0.134	4.79	0.194	29.2
EC-02-FT-080626-URS	0.15	0.173	5.73	0.062	37.1
Screening Criteria					
DEQ ATLs (mg/kg - wet wt)					
Human (Carcinogens General/Recreational)	0.0062	--	--	--	--
Human (Carcinogens Subsistence/Tribal)	0.00076	--	--	--	--
Human Non-carcinogens (General/Recreational)	1.2	4.0	--	0.5	--
Human Non-carcinogens (Subsistence/Tribal)	0.15	0.49	--	0.5	--
FINAL SCREENING CRITERION	0.0062	4	--	0.5	--

Units are in milligrams per kilogram (mg/kg) - wet weight.

Highlighted results exceed one or more screening level values.

If more than one criterion are exceeded by the same detected concentrations, then the related detected concentrations are yellow-highlighted. Bold numbers represent the criteria that are exceeded by the detected concentrations.

If more than one criterion is exceeded by different detected concentrations, a different color is assigned to each criterion exceeded.

DEQ ATLs - Acceptable tissue levels (protective of humans ingesting fish/shellfish), *Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment*, Oregon Department of Environmental Quality Environmental Cleanup Program. January 31, 2007; updated April 3, 2007.

Table B-24
Screening of Fish Tissue Data for Applegate River downstream of confluence with Elliot Creek
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Applegate River downstream of confluence with Elliott Creek					
AR-02-FT-080627-URS	0.16	0.145	3.15	0.017	33.5
AR-02-FT-DUP-080627-URS	0.13	0.133	3.30	0.024	30.3
Screening Criteria					
DEQ ATLS (mg/kg - wet wt)					
Human (Carcinogens General/Recreational)	0.0062	--	--	--	--
Human (Carcinogens Subsistence/Tribal)	0.00076	--	--	--	--
Human Non-carcinogens (General/Recreational)	1.2	4.0	--	0.5	--
Human Non-carcinogens (Subsistence/Tribal)	0.15	0.49	--	0.5	--
FINAL SCREENING CRITERION	0.0062	4	--	0.5	--

Units are in milligrams per kilogram (mg/kg) - wet weight.

Highlighted detected concentrations exceed one or more screening level values. Bold numbers are criteria that are exceeded.

If more than one criterion are exceeded by the same detected concentrations, then the related detected concentrations are yellow-highlighted. Bold numbers represent the criteria that are exceeded by the detected concentrations.

DEQ ATLS - Acceptable tissue levels (protective of humans ingesting fish/shellfish), *Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment*, Oregon Department of Environmental Quality Environmental Cleanup Program. January 31, 2007; updated April 3, 2007.

Table B-25
Screening of Fish Tissue Data for Applegate Reservoir
Screening-Level Human Health Risk Assessment
Blue Ledge Mine

Sample Name	Arsenic	Cadmium	Copper	Lead	Zinc
Applegate Reservoir					
ARV-02-FT-080627-URS	0.14	0.049	2.29	0.027	22.9
Screening Criteria					
DEQ ATLS (mg/kg - wet wt)					
Human (Carcinogens General/Recreational)	0.0062	--	--	--	--
Human (Carcinogens Subsistence/Tribal)	0.00076	--	--	--	--
Human Non-carcinogens (General/Recreational)	1.2	4.0	--	0.5	--
Human Non-carcinogens (Subsistence/Tribal)	0.15	0.49	--	0.5	--
FINAL SCREENING CRITERION	0.0062	4	--	0.5	--

Units are in milligrams per kilogram (mg/kg) - wet weight.

Highlighted results exceed one or more screening level values.

If more than one criterion are exceeded by the same detected concentrations, then the related detected concentrations are yellow-highlighted. Bold numbers represent the criteria that are exceeded by the detected concentrations.

DEQ ATLS - Acceptable tissue levels (protective of upper trophic level predators), *Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment*, Oregon Department of Environmental Quality Environmental Cleanup Program. January 31, 2007; updated April 3, 2007.

Table B-26
Estimated Potential Excess Human Health Cancer Risk
Fish Tissue Data
Blue Ledge Mine

Sample Name	Arsenic ^a	Potential Excess Cancer Risk
Elliott Creek		
EC-07-FT-080626-URS	0.24	3.9E-05
EC-04-FT-080626-URS	0.15	2.4E-05
EC-02-FT-080626-URS	0.15	2.4E-05
FINAL SCREENING CRITERION	0.0062	
Applegate River downstream of confluence with Elliott Creek		
AR-02-FT-080627-URS	0.16	2.6E-05
AR-02-FT-DUP-080627-URS	0.13	2.1E-05
FINAL SCREENING CRITERION	0.0062	
Applegate Reservoir		
ARV-02-FT-080627-URS	0.14	2.3E-05
FINAL SCREENING CRITERION	0.0062	

EC = Elliott Creek.

AR = Applegate River between mouth of Elliott Creek and head of Applegate Reservoir.

ARV = Applegate Reservoir.

Highlighted detected concentrations exceed the most stringent criterion. Bold numbers indicate the criteria which were exceeded.

Bold numbers indicate Excess Carcinogenic Risks that exceed 1.0E-06.

^a The only metal detected at concentrations that exceeded criteria is arsenic. The background concentration, rather than a criterion, was used to calculate HQ values. Arsenic is a carcinogen. Since criteria for arsenic are based on protection of human receptors at 1.0E-06, background concentrations will be treated as if they are protective to this level.

SCREENING LEVEL HHRA ADDENDUM

List of Tables

Table B-27 – Estimated Excess Cancer Risk for Drinking Water

Table B-28 – Comparison of 2005 Waste Rock Data to Soil Screening Criteria

After the draft SL-HHRA and SL-ERA had been prepared, it was discovered that some of the residents of the small community at Joe Bar utilized groundwater as a drinking water source. Therefore, sampling of groundwater sources at Joe Bar was conducted in the fall of 2008. These results can now be included in the SL-HHRA. The only metal present at concentrations that exceeded a human health criterion protective of drinking water is arsenic (Table 1).

Drinking Water Sources at Joe Bar:

Three drinking water sources used by the community in Joe Bar were sampled in the fall of 2008: the spring located on the north side of the valley (unconnected to Elliot Creek) that is used by the Ruetiger residence; and the two groundwater wells located at the Ziem residence and the Neilson residence. These are the only places where groundwater is used as a source of drinking water along Joe and Elliot Creeks.

Groundwater obtained from the well on the Ziem property is approximately 60 feet deep and is located approximately 200 feet from Elliot Creek. The water is used for drinking, cooking, and showering. Mr. Ziem also mentioned that Elliot Creek water is used for watering gardens and as drinking water for dogs and horses.

Groundwater for the Neilson property is obtained from a well located approximately 100 feet from Elliot Creek. No well depth information was available.

Human Health Criteria Used to Assess Risk from Arsenic Present in Groundwater:

Three different types of drinking water criteria were used to compare against groundwater analytical results for arsenic:

1. U.S. EPA 2006 drinking water maximum contaminant levels (MCLs) – MCLs are federal criteria protective of *public* drinking water sources. Some of the MCLs are calculated based on levels that are protective of human health; some are based on best available water-cleaning technology. The MCLs based on human health consider the exposure pathway of ingestion of drinking water. MCLs are directly *applicable* to public drinking water sources and therefore can be legally enforced. However, MCLs are also relevant and appropriate (but not directly applicable) to apply to single-residence groundwater wells, although they cannot be legally enforced in this situation. Thus, the U.S.EPA MCL for arsenic (10 ug/L) is relevant and appropriate to apply to the arsenic results obtained from the two groundwater wells sampled in Joe Bar.

2. California 2009 MCLs – Because Joe Bar is located in California, criteria obtained from the California drinking water regulations must also be compared to results obtained from groundwater wells at Joe Bar. In the case of arsenic, the MCL is 10 ug/L and has the same caveats attached to it as described above for the U.S. EPA MCL for arsenic.
3. U.S. EPA 2008 Regional Screening Levels (RSLs) – RSLs are published by U.S. EPA for the Mid-Atlantic Region, and include risk-based guidance values originally published by U.S. EPA Region 3, 6, and 9. They are considered the most applicable of the EPA risk-based guidance values to apply in California. For arsenic, the tapwater RSL of 0.045 ug/L is significantly more stringent than either of the MCLs discussed above. This is due to the fact that the RSL for arsenic is based on the most-current toxicity information. In addition, RSLs for tapwater take both ingestion and inhalation exposure pathways into account; however the additional pathway of inhalation is irrelevant for arsenic, as arsenic is not a volatile compound.

Calculation of PECR Value for Arsenic in Groundwater:

To obtain a PECR value for arsenic concentrations detected in groundwater, the detected concentration was compared to the RSL of 0.045 ug/L. The RSL is based on a protective level of 1×10^{-6} (1.0E-06) for human exposure to a carcinogen. The formula for this calculation is:

Detected concentration of arsenic in ug/L / X = 0.045 ug/L / 10^{-6}

PECR = X

Solving for X results in a PECR value for the detected concentration of arsenic. Any exceedance of a PECR of 1E-06 represents unacceptable risk to human receptors. Please refer to Table B-27 for the results of this screening.

Results of Screening of Groundwater Data:

The groundwater drawn from a spring on the north side of the valley (used by Ruetiger residence) was found to contain 0.22 ug/L arsenic. This concentration does not exceed either of the MCL values, but does exceed the RSL value for arsenic by nearly an order of magnitude, resulting in a PECR of 4.9E-06. This indicates that local geological and/or hydrogeological conditions probably cause significant background concentrations of arsenic to be present. There is no known way that arsenic present in surface water in Elliot Creek could impact the spring on the north side of the valley.

Groundwater samples collected from the Ziem and Neilson groundwater wells contain concentrations of arsenic (6.24 ug/L and 2.04 ug/L, respectively, resulting in PECRs of 1.4E-04 and 4.4E-05, respectively) that also do not exceed the MCLs for arsenic, but significantly exceed the RSL for arsenic by approximately two orders-of-magnitude.

Because these wells are located 200 and 100 feet from Elliot Creek, respectively, and because the related arsenic concentrations are significantly higher than those detected in surface water samples collected from Joe and Elliot Creeks, it appears likely that arsenic concentrations in groundwater in the area of Joe Bar contain naturally-high levels of arsenic, which is also naturally present area soils at relatively high concentrations.

Note that multiple samples of surface water collected from Joe Creek in June 2008 did not contain detectable levels of arsenic (i.e., less than 0.07 ug/L), but that surface water samples collected from Elliot Creek (both downstream *and* upstream of its confluence with Joe Creek) contained detectable concentrations of arsenic that ranged from 0.22 ug/L to 0.50 ug/L (please see Tables B-5 and B-6 in Appendix B of the SI Report). This is further evidence that concentrations of arsenic exist in surface water in Elliot Creek that appear to be of natural origin, and are not associated with input from Joe Creek. The fact that groundwater concentrations of arsenic present in the two wells at Joe Bar are much higher than those detected in the surface water of Elliot Creek also appears to indicate that regional groundwater contains arsenic derived from local soils, and is not due to migration of Elliot Creek surface water to groundwater at Joe Bar.

Assessing Potential Exposure of Human Receptors to Waste Rock

Waste rock located near the mine adits is assumed to provide two types of exposure to human and/or ecological receptors:

1. Metals associated with waste rock leach out or migrate as runoff into the upper surface waters of Joe Creek, causing unacceptable impacts to aquatic biota in the creek.
2. Site workers moving or removing waste rock could be exposed to metals through incidental ingestion of waste rock particles, dermal contact with waste rock materials, and inhalation of fine particles of waste rock or dust containing waste rock material. These same exposures are possible for short-term site visitors, although the exposure durations are likely to be less for visitors than for workers.

Because waste rock is an uncommon medium to be assessed for potential risk to human receptors (as well as ecological receptors), attempting to quantify or semi-quantify human health risks based on dermal contact with waste rock and inhalation of related waste rock dust would require significant research, as no default exposure factors are available. In light of the fact that the waste rock is located in a remote area, exposure duration times for visitors would be relatively short. If the waste rock is removed, on-site remediation workers should wear appropriate protective clothing and a dust mask at minimum to avoid exposure to metals associated with the waste rock. It is assumed that the bulk of exposure of human and ecological receptors to the waste rock occurs indirectly through contact with abiotic media in Joe Creek located downstream of the mine, which has been impacted by migration of metals from the waste rock.

However, a rough estimate of potential exposure risks to human receptors directly contacting waste rock can be made for arsenic and lead by comparing waste rock results

obtained in 2005 to soil criteria used in the SL-HHRA attached to this SI report. Waste rock is not soil, but comparison of waste results to soil criteria will provide a qualitative estimate of potential risks to human receptors that directly contact the waste rock. Please see Table B-28 for the results of this comparison.

As presented in Table B-28, the waste rock concentrations detected in 2005 are much higher than the three types of soil criteria used as screening numbers. California regional soil levels represent typical background concentrations of metals found in California soils; the two USEPA Regional Screening Level soil criteria are based on residential soil and industrial soil, respectively. Use of the Regional Screening Levels is highly conservative in regard to assessing potential exposure of human receptors to the Blue Ledge Mine waste rock, which is located in a fairly remote area. However, the comparison does allow for a rough estimation of potential human health risks that might be related to directly contacting the waste rock. Because the mean and maximum concentrations of arsenic and lead significantly exceed the soil criteria used for screening purposes (this is also true for the minimum concentration of arsenic detected), it can be assumed that there is an unacceptable risk to human receptors that come into direct contact with the waste rock.

TABLE B-27
ESTIMATED POTENTIAL EXCESS CANCER RISK FOR DRINKING WATER DATA
BLUE LEDGE MINE

Sample Name	Location of Sample Collection	Arsenic ^a (ug/L)		Potential Excess Cancer Risk
WS-1	Ziem's Residence	6.24		1.4E-04
WS-2	Ruetiger's Residence	0.22	J	4.9E-06
WS-3	Neilson's Residence	2.04		4.5E-05
FINAL SCREENING CRITERION		0.045		

^a = arsenic is a carcinogen. Criteria for arsenic are thus based on protection of human receptors at an acceptable risk of 1.0E-06. Detected values represent dissolved concentrations.

ug/L = micrograms of arsenic per liter of groundwater.

J - The result is an estimated concentration

Highlighted results exceed one or more screening criteria.

Bold font = criterion that was exceeded.

**TABLE B-28
COMPARISON OF 2005 WASTE ROCK DATA TO SOIL CRITERIA
BLUE LEDGE MINE**

Contaminant	Maximum Concentration (mg/kg)	Minimum Concentration (mg/kg)	Mean Soil Concentration (mg/kg)	California Region Soil Level ^a (mg/kg)	USEPA Regional Screening Level for Residential Soil ^b (mg/kg)	USEPA Regional Screening Level for Industrial Soil ^c (mg/kg)
Arsenic	287	62.4	135	3.5	0.39	1.6
Lead	2,710	616	1,349	23.9	400	800

Data results obtained from U.S. EPA Region IX San Francisco CA. Memorandum: *Request for a Time-Critical Removal Action at the Blue Ledge Mine site, Rogue River National Forest, Siskiyou County, California*. From: Harry Allen, Emergency Response Section, To: Daniel Meer, Chief, Response, Planning, and Assessment Branch.

a = Obtained from California Regional Soil Levels - 1996. Bradford, G.R., A.C. Chang, A.L. Page, D. Bakhtar, J.A. Frampton, and H. Wright. Background concentrations of trace and major elements in California soils. Kearney Foundation of Soil Science, University of California Special Report, U.C. Riverside and Cal/EPA, DTSC.

b and c = U.S. EPA Regional Screening Levels. 2008. Obtained at http://www.epa.gov/reg3hwmd/risk/human/rb_concentration_table/sersguide.htm. October 9, 2008.