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TECHNICAL MEMORANDUM

To: Michael Wilcox (USDA Forest Service)
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Distribution: Scott Miller (Newmont Mining)
Date: April 2015
Subject: Ecological Risk-Based Preliminary Remediation Goals (PRGs) for the former Ross-Adams Mine Site, Prince of Wales Island, AK
Project No.: C537.0205

INTRODUCTION

A screening-level ecological risk assessment (SLERA)(Integral Consulting and Tetra Tech 2015) was conducted in support of an engineering evaluation/cost analysis (EE/CA)(WME 2015) for remediation of the former Ross-Adams Mine site on Prince of Wales Island, AK. During the June 12, 2013 agency meeting in Anchorage, it was agreed that preliminary remediation goals (PRGs) would be defined for those metals with hazard quotients (HQ) greater than one for terrestrial ecological receptors exposed to soil in the non-mineralized area. For the non-mineralized areas¹ of the site, the SLERA identified seven chemicals of potential ecological concern with hazard quotients (HQ) greater than 1 (Table 1). As indicated in the SLERA, three of the seven chemicals in Table 1 (aluminum, manganese, selenium) have exposure point concentrations (EPCs) that are already below background threshold values (BTVs)². Consequently, four chemical-receptor pairs with HQ>1 and EPC>background are recommended for the development of PRGs:

¹ The non-mineralized area comprises the 300 Level and OSA exposure areas as described and characterized in the SLERA.

² This is due to the risk assessment methodology, which selects chemicals of interest based on comparisons of screening level values with maximum site concentrations rather than exposure point concentrations (EPCs) that are based on an upper 95 percent confidence level for the mean. Also, because ecological SLVs are generic and conservatively based, it is not unusual to find HQ>1 for EPC values that are within the range of background levels.

- Cadmium – Small mammals (masked shrew)
- Cobalt – Plants
- Lead – Birds (American Robin)
- Zinc – Plants or soil invertebrates.

This memorandum presents proposed cleanup levels expressed as risk-based PRGs for these chemicals of concern.

Several radionuclides (Ra-226 and Ra-228) were also identified as chemicals of concern in soil for ecological receptors (terrestrial animals) in the non-mineralized areas. However, this memorandum does not evaluate ecological PRGs for Ra-226 and Ra-228. Activity levels of Ra-226 and Ra-228 are highly correlated with gamma emissions and background gamma levels have been selected as the cleanup goal for non-mineralized areas (WME 2013).

Risk-based PRGs are upper concentration limits for specific chemicals in specific environmental media that are anticipated to protect ecological receptors (Efroymson et al. 1997; Suter et al. 2010). Risk-based PRGs are calculated by taking the forward going risk equation and rearranging the equation to solve for the concentration that corresponds to a specified level of risk. PRGs are intended to correspond to minimal and acceptable levels of effects on the general ecological assessment endpoints as defined in the ecological risk assessment. In general, they correspond to small effects on individual organisms which would be expected to cause minimal effects on populations and communities. Risk-based PRGs therefore are intended for comparison to spatially weighted exposure point concentrations in soil that are based on verification sampling following the removal action. The cleanup level will be based on the higher of the risk-based based PRG or background.

RECOMMENDED PRGS

For community receptors (plants and soil invertebrates), PRGs are the same as the media-based ecological soil screening level values (SLVs) that were used to judge risk in the SLERA:

- Cobalt – 13 mg/kg dw is the soil SLV for plants. However, this soil SLV is less than the BTV of 18 mg/kg dw soil identified in Table 2-1 in the SLERA (Integral and Tetra Tech 2013). Consequently, the BTV value of 18 mg/kg is recommended as the PRG for cobalt.
- Zinc – 120 mg/kg dw is the soil SLV for invertebrates and is recommended as the PRG for zinc.

For small mammals and birds, EPA (2007) methods were used to calculate PRGs for chemical concentrations in soil based on simultaneous exposure via the consumption of prey (earthworms), plants, and the incidental ingestion of soil by either a small mammal (the short-tailed shrew) or by a bird (the American robin). The same methods and assumptions were used in the SLERA to calculate risks (see Section 3.2.1 of the SLERA).

The calculation of PRGs is straight forward when the exposure equations are simple linear functions based on single exposure medium. However, the equations used to estimate risk to small mammals and birds are complex and based on exposure via consumption of soil and via consumption of food (plants and soil invertebrates). Bioaccumulation of cadmium and lead in plant and soil-invertebrate food varies non-linearly with changing metal concentrations in soil. Given this complexity, PRGs for cadmium and lead were determined iteratively using the Solver³ add-on function in Excel to determine the soil concentration that results in an HQ equal to 1. The accuracy of this method was checked manually by iteratively changing the soil EPC in the risk calculation spreadsheet until the HQ equals 1.

PRGs calculated by this methodology are:

- Cadmium – 1.3 mg/kg (based on the masked shrew)
- Lead – 18.4 mg/kg (based on the American robin). However, this risk-based PRG for soil is less than the BTV of 31 mg/kg dw soil identified in Table 2-1 in the SLERA (Integral and Tetra Tech 2014). Consequently, the BTV value of 31 mg/kg is recommended as the PRG for lead.

REFERENCES

- Efroymsen, R.A., G.W. Sutter II, B.E. Sample, D.S. Jones. 1997. Preliminary Remediation Goals for Ecological Endpoints. ES/ER/TM-162/R2. Oak Ridge National Laboratory, Oak Ridge TN.
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- Suter, G.W., R. A. Efroymsen, B. E. Sample, and D. S. Jones. 2000. Ecological Risk Assessment for Contaminated Sites. CRC Press, Boca Raton, FL. 410 pp.

³ Solver uses the “Generalized Reduced Gradient (GRG2) Algorithm” which is an advanced iterative approach for solving nonlinear problems.

USEPA. 2007. Exposure factors and bioaccumulation models for derivation of wildlife Eco-SSLs. OSWER Directive 9285.7-55. Revised April 2007. U.S. Environmental Protection Agency, Washington, DC.

WME. 2013. Technical Memorandum. Ross-Adams Non-mineralized Background Gamma Exposure Rate Cleanup Criteria. Worthington-Miller Environmental, Ft. Collins, CO.

WME. 2015. Engineering Evaluation/Cost Analysis, Ross-Adams Mine Site, Tongass National Forest, Prince of Wales Island, Alaska. Worthington-Miller Environmental, Ft. Collins, CO.

Table 1. Hazard Quotients and Recommended Preliminary Remediation Goals for Metals of Concern in the Non-mineralized Area (300 Level and OSA)^{a,b}

Area	Chemical of Concern	EPC (mg/kg)	BTV ^c (mg/kg)	EPC<BTV	Hazard Quotients for Receptors of Concern						Most Sensitive Receptor for PRG	Recommended PRG (mg/kg)
					Plants	Soil Invertebrates	Junco	Robin	Shrew	Vole		
300 Level	Aluminum	18,758	21,000	Yes	--	--	--	2	5	--	NR ^d	NR
	Cadmium	2.32	0.25	No	--	--	--	--	2	--	Shrew	1.3
	Cobalt	19.5	18.0	No	2	--	--	--	--	--	Plants	18
	Lead	96.2	31.0	No	--	--	3	4	--	--	Robin	31
	Manganese	2,282	4,000	Yes	10	5	--	--	--	--	NR	NR
	Selenium	1.54	2.70	Yes	3	--	--	--	--	--	NR	NR
	Zinc	257	24	No	2	2	--	--	--	--	Plants, invertebrates	120
OSA	Aluminum	17,837	21,000	Yes	--	--	--	2	5	--	NR	NR
	Lead	48.2	31.0	No	--	--	--	2	--	--	Robin	31

Notes:

-- = Hazard quotient is not greater than 1 for this chemical-receptor pair.

BTV = background threshold value

EPC = exposure point concentration

NR = none recommended

OSA = ore staging area

PRG = preliminary remediation goal

^aOnly metals with lowest observed adverse effects level-based hazard quotients greater than 1 are shown.

^bSource: Tables 4-2, 4-3, 4-7, 4-8, 4-9, and 4-10 in Appendix A (SLERA) of the Public Draft EE/CA (WME 2015).

^cThe BTV used for this evaluation is based on the maximum background concentration in non-mineralized soil for the combined OSA and 300-Level data.

^dNone recommended. NR because the EPC is below the BTV.