Syracuse Research Corporation
999 18th Street, Suite 1975
Denver, CO 80202
(303) 292-4760 phone
(303) 292-4755 fax

MEMORANDUM

To: Bob Feild, USEPA Region 7 RPM
Michael Beringer, USEPA Region 7 Toxicologist
From: Bill Brattin, Jennifer Walter
Date: March 16, 2009
Subject: Preliminary Remediation Goals for Protection of Excavation Workers from Lead in Sub-Surface Soil at the Omaha Lead Site

---

1.0 INTRODUCTION

In 2009, USEPA released a Human Health Risk Assessment for the Omaha Lead Site (OLS) that evaluated risks from lead in soil to children residing at homes within the final focus area (USEPA 2009a). The risk assessment noted that if the level of lead in soil is safe for exposure of children, it is also safe for exposure of adults. A potential exception to this principle comes when surface soils are cleaned up to levels that protect children, but the level of lead in subsurface levels may remain somewhat elevated. Although a child is not likely to be exposed to lead in subsurface soil, some categories of workers (e.g., excavation workers) may be exposed to contaminated sub-surface soil as part of their normal work activities.

The purpose of this document is to calculate a series of Preliminary Remediation Goals (PRGs) for lead in sub-surface soil that could be of potential concern to an excavation worker, depending on the frequency that the workers is engaged in excavation activities within the site. The resulting PRG values are then used to evaluate whether levels of lead observed in subsurface soil at the OLS are likely to be of potential concern to this population of workers.

2.0 BASIC EQUATIONS

USEPA has developed a standard approach for assessing risks associated with non-residential exposure to lead from soil (USEPA 2003). This approach uses the Adult Lead Methodology (ALM) to predict blood lead levels as a result of site-related soil exposure. The sub-populations of chief concern are pregnant women and women of child-bearing age, because the blood lead level of a fetus is nearly equal to the blood lead level of the mother. USEPA has established a health-based goal to ensure that there is no more than a 5% chance that the fetus of an exposed woman would have a blood lead level above 10 µg/dL.

The ALM predicts the blood lead level in an adult by summing the "baseline" blood lead level (PbB_0) (that which would occur in the absence of any site-related exposures) with the increment in blood lead that is expected as a result of exposure to lead in site soil. The latter is estimated by multiplying the average daily absorbed dose of lead from soil by a "biokinetic slope factor" (BKSF). Thus, the basic equation for exposure to lead in soil is:

$$PbB_{adult,central} = PbB_{0adult} + BKSF \cdot PbS \cdot IRs \cdot AFs \cdot (EFs/AT)$$

where:

$PbB_{adult,central}$ = Central tendency (geometric mean) blood lead concentration (µg /dL) in women of child-bearing age) that are exposed to soil at the site

PbB_0 = "Background" geometric mean blood lead concentration (µg /dL) in women of child-bearing age in the absence of exposure at the site

BKSF = Biokinetic slope factor (µg /dL blood lead increase per ug/day lead absorbed)

PbS = Soil lead concentration (µg/g)

IRs = Intake rate of soil (g/day)

AFs = Absolute gastrointestinal absorption fraction for lead in soil (dimensionless). The value of AFs is given by:

$$AFs = AF(food) \cdot RBA(soil)$$

EFs = Exposure frequency for contact with site soils (days/year)

AT = Averaging time (days)

Once the geometric mean blood lead value is calculated, the full distribution of likely blood lead values in the population of exposed women can then be estimated by assuming the distribution is lognormal with a specified inter-individual geometric standard deviation (GSD_i) for the population of concern. The 95th percentile of the distribution is given by the following equation:

$$PbB_{adult,95th} = PbB_{adult,central} \cdot GSD_i^{1.645}$$

Given the $PbB_{adult,95th}$ value, the concentration in the blood of the fetus is calculated as:

$$PbB_{fetus,95th} = PbB_{adult,95th} \cdot Ratio_{fetal/maternal}$$

The ratio of blood lead concentration in the fetus to that in the mother is generally around 0.9 (USEPA 2003). Consequently, the 95th percentile blood lead level in the mother that corresponds to a 95th percentile value of 10 µg/dL in the fetus is:

$$PbB_{adult,95th} = 10\ \mu g/dL / 0.9 = 11.1\ \mu g/dL$$

Combining and rearranging the equations above yields the following equation for calculating the concentration of lead in soil that is of potential concern to the fetus of an adult woman worker:

$$PRG = \frac{\left(\frac{11.1}{GSD_i^{1.645}}\right) - PbB_0}{BKSF \cdot IR \cdot AF \cdot (EF / AT)}$$

3.0 PARAMETER INPUT VALUES

Parameter input values selected for use are listed in Table 1. Most of the values are defaults recommended by USEPA (2003) for use in the ALM. Non-default values are discussed below.

IR

The soil ingestion rate for an excavation worker is assumed to be 0.1 g/day. USEPA (2009b) considers this value to be a reasonable default ingestion rate that has been commonly used as a central tendency estimate for contact-intensive adult scenarios (such as agricultural workers or construction workers).

AF

The absorption fraction of lead from soil is calculated using the site-specific RBA for soil of 0.8 as follows:

$$AF = 0.2 \cdot 0.8 = 0.16$$

This RBA value is the same as was used in the risk calculations for children, and is based on both *in vivo* and *in vitro* measurements (USEPA 2009a).

EF and AT

USEPA guidance indicates that the minimum exposure duration appropriate for modeling intermittent exposures is about 3 months, with a minimum exposure frequency of 1 day per week (USEPA 2003). The exposure duration must be sufficiently long to allow blood lead concentrations to approach quasi-steady state. Based on this, a value of 91 days (13 weeks) was assumed for AT.

There are no data available on the frequency that an excavation worker may be exposed at an individual property within the OLS. In the absence of data, a series of alternative values of EF were assumed, ranging from 1 day per week (13 days out of 91 days) up to 5 days per week (65 days out of 91 days).

PbB_0 and GSD_i

Blood lead summary statistics for PbB_0 and GSD_i are available from a series of National Health and Nutritional Evaluation Surveys (NHANES) performed by the National Center for Health Statistics of the Centers for Disease Control. Data collected during the years 1988-1994 (Phase 1 and 2 of NHANES III) for adult females (ages 17-45) in the Midwest Region of the United States indicate a baseline blood lead value (PbB_0) of 1.5 µg/dL, and a GSD_i of 2.18 (USEPA 2002). However, analysis of more recent NHANES data for the years 1999 to 2004 indicates that both PbB_0 and GSD_i are now somewhat lower, with a PbB_0 of 1.0 µg/dL and a GSD_i of 1.8 (SRC 2009). Although these values have not yet been incorporated into official USEPA guidance, they reflect the best available science and are used here for the purposes of evaluating potential risks to construction workers.

4.0 Preliminary Remediation Goals (PRGs)

Based on these inputs, the Preliminary Remediation Goals (PRGs) associated with differing assumed exposure frequencies are as shown below:

Assumed Exposure Frequency (days/week)	PRG* (ppm)
1	3500
2	1800
3	1200
4	880
5	710

* Values are shown to two significant figures

These PRG values represent the maximum acceptable <u>average</u> concentration of lead in subsurface soil that a worker may be exposed to in the OLS during a 13-week (91 day) work period. Note that it is not reasonable to assume that a worker will be exposed to subsurface soil at a single property for 13 weeks. Consequently, comparison of the PRGs to concentration values observed at individual properties is not appropriate. Rather, it is likely that a worker will be exposed at a number of different properties within this time span, and PRGs must be interpreted by comparison to the average concentration across all of the properties contacted.

5.0 EVALUATION OF SITE DATA

Data on the concentration of lead in subsurface soil collected during the Remedial Investigation (Black and Veatch 2001) at the OLS are summarized below:

Statistic	Soil Depth Interval			
	0-2”	0-8”	8-16”	16-24”
Count	550	548	548	549
Average	280	223	175	128

As shown, average lead concentrations tend to decrease as a function of increasing depth, which is consistent with the concept that most of the lead originates from surficial sources. Importantly, all of the average values for lead in soil at various depths are substantially lower than all of the PRGs for an excavation worker, even if exposure is assumed to be very frequent (5 days/week). Based on this, it is concluded that risks to excavtion workers in the OLS from exposure to lead in soil are not of significant health concern.

6.0 REFERENCES

Black and Veatch. 2001. Final Preliminary Assessment/Site Inspection Report, Omaha Lead Site, Omaha Nebraska. Prepared by Black and Veatch Special Projects Corp., August, 2001.

SRC. 2009. Blood Lead Summary Statistics Based on NHANES Data From 1999-2004.

USEPA. 2002. Blood Lead Concentrations of U.S. Adult Females: Summary Statistics from Phases 1 and 2 of the National Health and Nutrition Evaluation Survey (NHANES III). U.S. Environmental Protection Agency, Technical Review Workgroup for Lead. EPA 9285.7-52. March.

USEPA. 2003. Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil. Office of Solid Waste and Emergency Response. EPA-540-R-03-001. January.

USEPA. 2009a. Baseline Human Health Risk Assessment. Omaha Lead Site. Remedial Investigation Report, Volume III, Appendix M. Prepared for, and with oversight by U.S. Environmental Protection Agency Region 7, by Syracuse Research Corporation. February 2009a.

USEPA. 2009b. Frequent Questions from Risk Assessors on the Adult Lead Methodology. Appropriate Soil Ingestion Rate (IR) for a Construction Scenario. Available online at: http://www.epa.gov/superfund/health/contaminants/lead/almfaq.htm, last updated August 18, 2008.

TABLE 1
ALM INPUT PARAMETERS

Parameter	Value	Units	Basis
PbB_0	1.0	µg/dL	Average blood lead concentration for adult females (ages 17-45) in the Midwest Region, based on the most recent NHANES data collected during 1999 – 2004 (SRC 2009).
BKSF	0.4	µg/dL per µg/day absorbed	USEPA (2003) default
GSD_i	1.8		GSD for adult females (ages 17-45) in the Midwest Region, based on the most recent NHANES data collected during 1999 – 2004 (SRC 2009)
$Ratio_{fetal/maternal}$	0.9	--	USEPA (2003) default
AF_{food}	0.2	--	USEPA (2003) default
IR_s	0.1	g/day	Default for contact intensive worker (USEPA 2009b)
RBA_{soil}	0.8	--	Site-specific measurements (see USEPA 2009a)
EF	1-5	days/week	Assumed
AT	91	days/year	Assumes 13 weeks (7 days/week x 13 weeks).