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TECHNICAL MEMORANDUM ADULT LEAD METHODOLOGY DERIVED TARGET LEAD
CONCENTRATIONS FOR INDUSTRIAL LAND USE CNC CHARLESTON SC

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CH2MHILL

Adult Lead Methodology (ALM) Derived Target Lead Concentrations for Industrial Land Use

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Introduction

Lead has been detected in surface soils at several sites across the Charleston Naval Complex (CNC) at concentrations above background levels. In many cases the elevated lead concentrations appear to be associated with past industrial activities at the CNC, such as handling/use of lead-based paints, sandblasting operations involving lead-based painted materials, or handling/refurbishing or recycling of lead batteries.

For sites designated for unrestricted land use, the BRAC Cleanup Team (BCT) has agreed to use the generally accepted target cleanup level of 400 milligrams per kilogram (mg/kg) as an appropriate target cleanup level for lead in surface soil. In order to proceed with remedial planning and close-out for sites located in areas targeted for industrial land use, the BCT needs an appropriate risk-based target cleanup level for lead in surface soil. This memorandum presents the proposed approach for determining a target surface soil cleanup level for lead that is protective of human health for sites with current and future industrial land use scenarios. The proposed approach is based on the U.S. Environmental Protection Agency (EPA)'s Adult Lead Methodology (ALM).

Description of EPA's Adult Lead Methodology

EPA's Technical Review Workgroup (TRW) for Lead developed the ALM, which was released as an interim report entitled *Recommendations of the Technical Review Workgroup (TRW) for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (August 2001). It is available from EPA's website at:

<http://www.epa.gov/superfund/programs/lead/adult.htm>.

The ALM model is simple, easy to use, and spreadsheet-based. This latest ALM guidance includes a re-evaluation of the adult lead model that was previously developed by the EPA, titled *Recommendations of the Technical Review Workgroup (TRW) for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (December 1996), and compares the 1996 proposed model to various lead models proposed since its publication. This review by the TRW resulted in retaining the previously proposed lead model as the interim guidance, and has since been named the ALM. The default-input factors from the 1996 guidance were not changed. Thus, any previously proposed lead

target concentrations developed using this approach during previous work at the CNC may still be valid. The EPA is in the process of developing yet another model, referred to as the All Ages Lead Model. Until this model becomes available, the ALM is retained for calculating target lead concentrations protective of adult receptors (e.g., site workers).

The ALM is a modified version of the approach proposed by Bowers et al. (1994), which has been used by several EPA regions in calculating target lead concentrations. The ALM uses a biokinetic slope factor (BKSF) to represent lead biokinetics, and a relatively simple exposure model in which all exposure pathways, except the soil ingestion pathway, are represented by a background blood-lead concentration (PbB). The equations for the ALM are presented below:

$$RBC = PbS = ((PbB_{adult, central, goal} - PbB_{adult,0}) \times AT) \div (BKSF \times IR_s \times AF_s \times EF_s)$$

$$PbB_{adult, central, goal} = PbB_{fetal, 0.95, goal} \div (GSD_{i, adult} \times R_{fetal/maternal}),$$

where:

RBC = risk-based concentration soil concentration (PbS) that would be estimated to result in a specified central tendency PbB concentration in adults (i.e., women of child-bearing age) at a site ($PbB_{adult, central, goal}$) and corresponding 95th percentile fetal PbB concentration ($PbB_{fetal, 0.95, goal}$).

$PbB_{adult,0}$ = typical blood-lead concentration ($\mu\text{g}/\text{dL}$) (i.e., background) in women of child-bearing age at the site in the absence of exposure to contamination.

PbS = soil lead concentration (mg/kg).

AT = averaging time: the total period of exposure (365 days/year for long-term exposures).

BKSF = ratio of increase in typical adult PbB levels to average daily lead uptake ($\mu\text{g}/\text{dL}$ PbB increase per $\mu\text{g}/\text{day}$ lead uptake).

IRs = intake rate of soil, includes both outdoor soil and indoor soil-derived dust (g/day).

AFs = absorption factor for ingested lead from soil and dust (dimensionless).

EFs = exposure frequency for chronic exposures (days/year).

$PbB_{adult, central, goal}$ = goal for central estimate of blood lead concentration ($\mu\text{g}/\text{dL}$) in adults that come in contact with site contamination. The goal is intended to ensure that $PbB_{fetal, 0.95, goal}$ does not exceed 10 $\mu\text{g}/\text{dL}$.

$PbB_{fetal, 0.95, goal}$ = goal for the upper 95th percentile blood lead concentration ($\mu\text{g}/\text{dL}$) among fetuses of women exposed to contaminated soil to be less 10 $\mu\text{g}/\text{dL}$ (5-percent chance it could be >10 $\mu\text{g}/\text{dL}$).

$GSD_{i,adult}$ = estimated geometric standard deviation; the GSD among adults (i.e., women of child-bearing age) that have exposures to similar onsite lead concentrations, but that have non-uniform response (intake, biokinetics) to site lead and non-uniform offsite lead exposures

$R_{fetal/maternal}$ = constant of proportionality between fetal PbB concentration at birth and maternal PbB concentration.

The default factors for each of the above input parameters for the equation are listed in Table 1.

When a range of variables are available, a midpoint value was used in deriving a lower target lead concentration. For example, $GSD_{i,adult}$ default values were recommended to be 1.8 (for homogeneous population) and 2.1 (for heterogeneous population). A value of 1.95 (midpoint) was used in the ALM assuming that more sensitive population could be present among workers. All other factors are the default values provided in the EPA example spreadsheets.

Using these values, the ALM calculates a target cleanup value for industrial use sites of 1,218 mg/kg. At sites where remedial actions are being considered, average site concentrations will be compared with the ALM calculated value of 1,218 mg/kg, as the post-remedial exposure point concentration for protection of human health for industrial land use.

Additionally, a site-specific soil screening level (SSL) should be calculated for determining the appropriate target cleanup level for protection of groundwater quality. An SSL screening value of 400 mg/kg is being used as a conservative screening criterion. A site-specific SSL calculation should be developed for both a paved and unpaved site condition. A site-specific leachability value is developed when synthetic precipitation leaching procedure (SPLP) data are available.

TABLE 1
EPA Interim Adult Lead Methodology (ALM) - Target Lead Concentrations Protective of an Adult Worker

| Exposure Parameter | Description | Adult Worker | Source ¹ |
|---|--|--------------|---------------------|
| RBC | Risk-Based Concentrations (RBCs) expressed in mg/kg; or PbS = Soil Lead Concentration ($\mu\text{g/g}$ or mg/kg) | 1,218 | Calc. |
| PbB_{adult,central,goal} | Goal for central estimate of Blood Lead Concentration expressed in $\mu\text{g/dl}$; | 3.7 | Calc. |
| PbB_{adult,0} | Typical Blood Lead Concentration ($\mu\text{g/dL}$) in adults, (i.e., women of child-bearing age) in absence of exposures to the site | 2.0 | A |
| PbB_{fetal,0.95,goal} | Goal for 95 percent blood lead concentration ($\mu\text{g/dL}$) in fetuses from exposures to women workers of childbearing age | 10.0 | A |
| BKSF | Biokinetic Slope Factor expressed in ($\mu\text{g/dL}$) per ($\mu\text{g/day}$) or day/dl; | 0.4 | A |
| IR_s | Intake rate for soil, including both indoor and outdoor soil-derived dust (g/day) (50 mg/day) | 0.05 | A |
| AF_s | Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless) | 0.12 | A |
| EF_s | Exposure Frequency for contact with assessed soils and/or dust derived part from site soils (days/year) | 219 | B |
| AT | Averaging time; 365 days/year | 365 | B |
| GSD_{i,adult} | Geometric standard deviation of the responses to lead exposure, on-site and offsite (unitless) 1.8-uniform population, 2.1 –heterogeneous population | 1.95 | A |
| R_{fetal/maternal} | Constant proportionality between fetal blood lead concentration at birth and maternal blood lead concentration (dimensionless) | 0.9 | A |

¹Sources:

A. EPA. 2001. Review of Adult Lead Models: Evaluation of Models for Assessing Human health Risks Associated with Lead Exposure at Non-Residential Areas of Superfund and Other Hazardous Waste Sites, August, 2001

B. EPA. 1991. Human Health Evaluation Manual, Part B: "Development of Risk-based Preliminary Remedial Goals". Office of Solid Waste and Emergency Response. OSWER Directive 9285.7-01B. December 13, 1991.