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Risk-Based Screening and Assessment Approach for Waste Area Group 1 Soils

Robin VanHorn
Sherri Stacey

Idaho Completion Project

Bechtel BWXT Idaho, LLC

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Robin VanHorn
Sherri Stacey

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Idaho Completion Project
Idaho Falls, Idaho 83415

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Approved by

Gary McDaniel, WAG 1 Project Engineer — 5/10/04 Date

Jim Jessmore, V-Tank Project Manager — 5-12-04 Date

ABSTRACT

This report describes a risk-based screening method for assessing potentially contaminated soils at the Idaho National Engineering Laboratory, Test Area North, Waste Area Group 1. The method addresses contaminants during remediation and closure using a risk-based assessment approach that allows rapid screening and directs the development of a cleanup goal for those contaminants that exceed screening criteria. This report presents the screening approach for both human and ecological receptors, taking into consideration all relevant exposure pathways. Data is presented identifying and characterizing both radioactive and nonradioactive contaminants of concern to be used with this risk-based screening method.

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ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPOC	contaminant of potential concern
CSM	conceptual site model
D&D	decontamination and dismantlement
EPA	U.S. Environmental Protection Agency
ESBL	ecologically based screening level
ESS	Exposure Scenario Based Screening
FRG	final remediation goal
HHRA	Human Health Risk Assessment
HI	hazard index
IS	initial screening
LWTS	liquid waste treatment system
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
NPR	New Production Reactor
OU	operable unit
PRG	preliminary remediation goal
RAG	risk assessment guidance
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RD/RA	remedial design/remedial action
RD/RAWP	Remedial Design/Remedial Action Work Plan
ROD	Record of Decision
SLQ	screening level quotient
SSL	soil screening level

TAN	Test Area North
TSF	Technical Support Facility
TSLQ	total screening level quotient
UCL	upper confidence level
WAG	waste area group

Risk-Based Screening and Assessment Approach for Waste Area Group 1 Soils

1. INTRODUCTION

This risk-based screening approach provides a process to evaluate selected existing and new soil contamination sites at Test Area North (TAN), Operable Unit (OU) 1-10, at the Idaho National Engineering and Environmental Laboratory to determine if contaminant risk drivers may be present in addition to, or other than, Cs-137. This approach will allow assessment of these contaminants and the development of additional remediation goals for use during cleanup that ensure protection of human health and the environment.

The *Final Record of Decision for Test Area North, Operable Unit 1-10* (DOE-ID 1999a) presented the selected remedial actions to be carried out for contaminated soils at Waste Area Group (WAG) 1. In this Record of Decision (ROD) (DOE-ID 1999a) (hereinafter referred to as the OU 1-10 ROD), a final remediation goal (FRG) of 23.3 pCi/g was developed for Cs-137 for sites TSF-09/18 (V-Tanks) and TSF-26 (PM-2A Tanks). This FRG was identified based on the original characterization performed during the remedial investigation sampling of the soils at these sites as part of the *Comprehensive Remedial Investigation/Feasibility Study for Test Area North Operable Unit 1-10* (DOE-ID 1997) (hereinafter referred to as the OU 1-10 Comprehensive RI/FS [remedial investigation/feasibility study]).

During characterization of these sites, Cs-137 was determined to be the primary risk driver. In the OU 1-10 ROD, a Cs-137 FRG of 23.3 pCi/g was developed based on 1E-04 risk to a hypothetical future resident at the site, due to exposure solely from Cs-137. Characterization for contaminated soil above or adjacent to tanks and piping at sites TSF-09/18 and TSF-26 indicates that Cs-137 is the only contaminant at levels of concern. This characterization did not include the assessment of contamination that could exist in soil beneath the piping and tanks due to leaks. No sampling was performed to characterize these soils, and uncertainty remains that the soil may be potentially contaminated by leaks from the tanks or piping may have other contaminants present at levels of concern. In addition, three new sites, TSF-46, TSF-47, and TSF-48, have been identified. These new sites also potentially contain contaminants that have leaked from the TAN-616 Liquid Waste Treatment System (LWTS) or indirectly through LWTS building foundations.

The tanks and piping associated with both the V-Tanks and PM-2A Tank sites are part of the TAN-616 LWTS (INEEL 2001). This system was designed to collect, store, and concentrate radionuclide contaminated liquid waste from TAN facilities. The majority of the radioactive liquid waste was from decontamination of equipment and facilities at the TAN Technical Support Facility (TSF). Liquid waste collection tanks V-1, V-2, and V-3 and sump tank V-9 (referred to as the V-Tanks) still contain waste that is representative of the waste that was treated through the TAN-616 LWTS. Similarly, any leaks from LWTS tanks and piping would have waste of the same or very similar composition as the V-Tanks.

During remedial action of the TSF-09/18 V-Tanks and the TSF-26 PM-2A Tanks, evidence of leaks from tanks and piping will be investigated as described in the associated Remedial Design/Remedial Action Work Plans (RD/RAWPs) and Closure Plans. In addition, the three new sites, TSF-46, TSF-47, and TSF-48, will be sampled and assessed under the "Group 2 Remedial Design/Remedial Action Work Plan Addendum for the Assessment and Cleanup of V-Tanks Area New Sites (DRAFT)" (DOE-NE-ID 2004a). Finally, additional new soil sites in the TSF area may be identified and require sampling and assessment. In all of these cases, the risk-based screening process addressed in this document may be used to determine and/or confirm if the risk from the contaminants at the sites exceed

cleanup levels, the contaminant(s) that drive cleanup, and the FRGs. Any proposed cleanup level will be based on accepted risk assessment methods and will be designed to ensure protection of human and ecological receptors.

1.1 Risk-Based Screening and Assessment Process

As noted above, in evaluating the nature and extent of Cs-137 contamination during remediation, it is important to ensure that other/additional detected contaminants do not require cleanup to protect human and ecological receptors. It is desirable to have a means to quickly determine those contaminants that may be of concern and, if necessary, to provide a goal for cleanup that can streamline remedial activities. To address these contaminants during remediation and closure, a risk-based assessment approach was developed that allows rapid screening and directs the development of a cleanup goal for those contaminants that exceed screening criteria.

This approach is based on the risk assessment process documented in the OU 1-10 Comprehensive RI/FS (DOE-ID 1997). It assumes that soils at the INEEL are generally remediated to total concentrations contributing less than 1E-04 total risk and/or a hazard index (HI) of 1.0 to the future residential human health scenario (100 years), and a HI of 10 for ecological receptors. It will use accepted risk-based concentrations (RBCs) for both screening and development of cleanup criteria. Communication with State and Federal agencies will include a brief risk-based assessment report that documents the results of this process and includes the proposed actions. This process should streamline efforts and result in significant cost savings during the assessment and remediation process. It is designed to ensure that remediation of soils at these sites is compliant with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC§ 9601 et seq.) and the Resource Conservation and Recovery Act (RCRA) (42 USC§ 6901 et seq.).

This document presents the RBCs that will be used for comparison as discussed in Sections 2 and 3. Sections 4 and 5 present the screening approach for both human and ecological receptors. A multi-step spreadsheet has been developed to provide a rapid means to use the screening steps as discussed in Section 6. Any contaminant not eliminated by this screening will be further addressed using accepted risk assessment methods, or appropriate cleanup goals will be developed as discussed in Section 7.

1.2 Summary of Applicable CERCLA Remediation and RCRA Closure Activities

As noted in the early part of this section, several of the soil sites listed are subject to both CERCLA RD/RAWPs and/or RCRA Closure Plans. Table 1 identifies the CERCLA sites with the respective closure plans and field sampling plans (FSPs) that support the closure plans. The closure plans and associated FSPs, in general, provide for collecting and analyzing the soil samples and then handing the sampling data off to CERCLA for assessment and cleanup if required. In some cases, additional soil sampling is also prescribed in an FSP that supports a CERCLA RD/RAWP. Data from both the RCRA closure sampling and the CERCLA characterization sampling may be used in the risk-based screening and assessment addressed in this document.

Table 1. Correlation between remediation and closure activities.

Site Number and Name	CERCLA RD/RAWP and FSP	RCRA Closure Plan and FSP
TSF-09/18 V-Tanks Soil beneath or adjacent to tanks and piping (after removal of tanks and piping)	DOE/NE-ID-11150, Group 2 RD/RAWP Addendum 2 for V-Tank Removal and Site Restoration (DOE-NE-ID 2004b). DOE/ID-11065, FSP for V-Tanks Site Characterization (DOE-ID 2003b). Included collection of samples near the bottom of tanks and piping. Data will be used in the risk-based screening and assessment. ICP/EXT-04-00289, FSP for V-Tanks Site Remediation Confirmation (ICP 2004). Will address soil sampling to confirm current FRG has been met.	DOE/ID-11053, HWMA/RCRA Closure Plan for Phase II: Feed Subsystem (V-Tanks) (DOE-ID 2003a). INEEL/EXT-02-01465, FSP for HWMA/RCRA Closure of the Feed Subsystem (V-Tanks) (INEEL 2003a). Addresses collecting samples from the excavation footprint after tanks are removed. Data will be used in the risk-based screening and assessment.
TSF-19 Caustic Tank Soil beneath or adjacent to tank (after removal of tank and piping)	This tank site soil is addressed as part of TSF-46, TAN-616 Soils (see below).	DOE/ID-11053, HWMA/RCRA Closure Plan for Phase II: Feed Subsystem (V-Tanks) (DOE-ID 2003a). Closure plan only addresses tank. Plan indicates soil is addressed as part of TSF-46, TAN-616 Soils.
TSF-21 Valve Pit (Valve Pit #2) Soil beneath or adjacent to valve pit (valve pit is removed)	DOE/NE-ID-11150, Group 2 RD/RAWP Addendum 2 for V-Tank Removal and Site Restoration. DOE/ID-11065, FSP for V-Tanks Site Characterization (DOE-ID 2003b). Included collection of samples near the bottom of tanks and piping. Data will be used in the risk-based screening and assessment. ICP/EXT-04-00289, FSP for V-Tanks Site Remediation Confirmation. Will address soil sampling to confirm current FRG has been met.	DOE/ID-11053, HWMA/RCRA Closure Plan for Phase II: Feed Subsystem (V-Tanks) (DOE-ID 2003a). INEEL/EXT-02-01465, FSP for HWMA/RCRA Closure of the Feed Subsystem (V-Tanks) (INEEL 2003a). Addresses collecting samples from under the former location of the valve pit. Data will be used in the risk-based screening and assessment.

Table 1. (continued).

Site Number and Name	CERCLA RD/RAWP and FSP	RCRA Closure Plan and FSP
TSF-26 PM-2A Tanks Soil beneath or adjacent to tanks and piping (after removal of tanks and piping)	DOE/NE-ID-11161, Group 3 RD/RAWP Addendum 1 for Tank Removal and Site Restoration (Pending). DOE/ID-10725, FSP for Group 1 Site Characterization (DOE-ID 2003c). Included collection of samples near bottom of PM-2A tanks and piping. Data will be used in the risk-based screening and assessment only if contingent sampling is required per the HWMA/RCRA Closure Plan. DOE/ID-11078, FSP for Group 3 PM-2A Tank Site Remediation Confirmation (DOE-ID 2003d). Will address soil sampling to confirm current FRG has been met.	DOE/ID-11076, HWMA/RCRA Closure Plan for Phase III: Holding Tank Subsystem (PM-2A Tanks) (DOE-ID 2004b). ICP/EXT-03-00056, Contingent FSP for Closure of PM-2A Tanks (INEEL 2004a). Addresses contingent sampling to be performed if there is evidence of a release from tanks or piping or as an alternative to other measures for piping. If sampling is necessary, data will be used in the risk-based screening and assessment.
TSF-46, TAN-616 Soils Soil beneath or adjacent to building TAN-616 (after removal of building foundation)	DOE/NE-ID-11152, Group 2 RD/RAWP Addendum for Assessment and Cleanup of V-Tank Area New Sites (DOE-NE-ID 2004a). DOE/NE-ID-11156, FSP for V-Tank Area New Sites (DOE-NE-ID 2004c). Will address both site characterization and remediation confirmation sampling. Site characterization data will be used in the risk-based screening and assessment.	DOE/ID-11021, HWMA/RCRA Closure Plan for Phase I: Treatment Subsystem (TAN-616) (DOE-ID 2004c). INEEL/EXT-02-00908, FSP for HWMA/RCRA Closure of the TAN-616 LWTF (INEEL 2004b). Addresses sampling under TAN-616, under Valve Pit #1, and under piping that passes through Valve Pit #1. Data will be used in the risk-based screening and assessment.
TSF-47, TAN-615 Sewer Line Soils Soil adjacent to sewer line	DOE/NE-ID-11152, Group 2 RD/RAWP Addendum for Assessment and Cleanup of V-Tank Area New Sites. DOE/NE-ID-11156, FSP for V-Tank Area New Sites. Will address both site characterization and remediation confirmation sampling. Site characterization data will be used in the risk-based screening and assessment if sufficient data was not obtained previously.	Not a RCRA closure. Was addressed under D&D in INEEL/EXT-02-01118, *Final Report for the Decontamination and Decommissioning of the Test Area North-615* (INEEL 2003b). INEEL/EXT-01-01453, FSP for Misc Locations at TAN in Support of the New TAN 008 VCO Project and the D&D of TAN-616 (INEEL 2002). Samples were collected as documented in logbooks ER-003-2002 and ER-078-2002. Data will be used in the risk-based screening and assessment.

Table 1. (continued).

Site Number and Name	CERCLA RD/RAWP and FSP	RCRA Closure Plan and FSP
TSF-48, Soils Beneath TAN-615 East and West Sumps Soil beneath sumps (after removal of sumps)	DOE/NE-ID-11152, Group 2 RD/RAWP Addendum for Assessment and Cleanup of V-Tank Area New Sites. DOE/NE-ID-11156, FSP for V-Tank Area New Sites. Will address both site characterization and remediation confirmation sampling. Site characterization data will be used in the risk-based screening and assessment if sufficient data was not obtained previously.	Not a RCRA closure. Was addressed under D&D in INEEL/EXT-02-01118, *Final Report for the Decontamination and Decommissioning of the Test Area North-615* (INEEL 2003b). INEEL/EXT-01-01453, FSP for Misc Locations at TAN in Support of the New TAN 008 VCO Project and the D&D of TAN-616 (INEEL 2002). Samples were collected as documented in logbooks ER-003-2002 and ER-078-2002. Data will be used in the risk-based screening and assessment.

2. IDENTIFICATION OF POTENTIAL CONTAMINANTS OF CONCERN

An initial contaminant inventory list was taken from Tables 2, B-1, and B-2 of the *Field Sampling Plan for Early Remediation Activities at Waste Area Group 1, Operable Unit 1-10 Remedial Action* (DOE-ID 2003b). This initial list of contaminants includes all contaminants that may be present in the V-Tanks, including all detected species and all undetected species whose detection levels were above universal treatment standard limits. The list presented in Table A-1 of this document includes additional contaminants of potential concern (COPCs) added through project discussion for sample strategy. For example, 1,4-dioxane was added (never analyzed for in the V-Tanks), but was a concern of a U.S. Environmental Protection Agency (EPA) agency member. Although there is some uncertainty concerning the contaminants that may have gone into the V-Tanks from the hot cells, this inventory is considered a comprehensive list of contaminants that may be present in soils at WAG 1. Including these COPCs in assessment of risk should ensure conservatism and protection of human and ecological receptors.

3. COMPILATION OF RISK-BASED CONCENTRATIONS

For human health (both future residential and occupational scenarios), RBCs for nonradionuclides were obtained from the most conservative values presented in EPA "Region 9 Preliminary Remediation Goals" (EPA 2003a). Additional data from "EPA Region 3 Risk-Based Concentrations (RBCs) Table" (EPA 2003b) were also used for chemicals that did not have a Region 9 value. To be protective of human health, the RBCs presented for nonradionuclides in Tables A-2 and A-3 are based on a 1E-06 cancer risk or Hazard Index <0.1.

The radionuclide RBC tables were provided for screening radionuclides in a memorandum from Jeff Fromm (Fromm 1996). The memorandum does not include the groundwater migration pathway. The RBCs taken from this memorandum are also based on 1E-06 cancer risk.

As discussed in Section 6, new generic soil-to-groundwater soil screening levels (SSLs) are available in accordance with the new guidance (EPA 1996a, EPA 1996b, EPA 2001). These generic values are not considered appropriate for use at the INEEL due to the greater depth to groundwater at this

site. It is assumed that the RBC screening is conservative enough to ensure protection of this pathway. However, site-specific values should be calculated when this pathway is a concern.

4. INITIAL CONTAMINANT SCREENING PROCESS

As described in the *Idaho National Engineering and Environmental Laboratory Comprehensive Facility and Land Use Plan* (DOE-ID 1996), TAN lies within an industrial area that is expected to remain under institutional controls for sometime (possibly the next 100 years). However, in past RI/FSs the human health assessment has been performed using both the occupational worker and future residential scenarios (see Section 5). Similar to the approach used in the Comprehensive RI/FS (DOE-ID 1997), both will be presented for evaluation (see Appendix A, Tables A-2 through A-7). The lowest value from either scenario will be used in the screening process. In addition, contamination may be present at depths below that typically used for the current occupational and future residential scenario. Therefore, these concentrations will be screened against the future residential scenario to be conservative. Note that Cs-137 has not been included in this screening process. An FRG has been provided for this contaminant in the OU 1-10 ROD (DOE-ID 1999a) that is designed to be protective of the future residential scenario at 1E-04 risk. In assessing other contaminants, the risk from Cs-137 also must be considered, as discussed in Section 7.

This initial contaminant screening process is summarized for human health in Figure 1, and for ecological receptors in Figure 2. The human health screening includes three steps: (1) background comparison, (2) nontoxic metal screen, and (3) comparison against RBCs. The ecological screening includes three steps: (1) background comparison, (2) nontoxic metal screen, and (3) comparison against ecologically based screening levels (EBSLs) and EPA Region 4 ecological SSLs (EPA 2000b). For this initial screening, the maximum concentration for each contaminant detected is used.

4.1 Human Health Screening

The contaminant screening method depicted in Figure 1 involves compiling all sampling data from either pre-remediation or post-remediation sampling and applying the screen to the maximum concentration observed for each chemical detected at that site. The screening steps for the initial screen (IS) are described in the following sections.

4.1.1 IS Step 1: Background Comparison

Step 1 in the chemical screening process is to distinguish waste contamination from naturally occurring background conditions. This comparison is conducted for all metals and radionuclides measured at a site. Because any organic contamination present at the site is assumed to be manmade, background comparisons are not appropriate and organics should be brought forward to Step 3. If the maximum concentration or activity for a given metal or radionuclide is less than or equal to representative background levels established by Rood et al. (Rood et al. 1996), the chemical is eliminated from further quantitative evaluation in the human health risk assessment (HHRA).

Rood et al. (Rood et al. 1996) established the representative background levels used for contaminant screening by combining data sets from previous studies and calculating the upper 95/95 tolerance limits for each metal and radionuclide. The upper tolerance limits represent the concentration or activity that is higher than 95% of all values in the data set, determined with 95% statistical confidence. Background values from Rood et al. (Rood et al. 1996) that were obtained from composite samples were

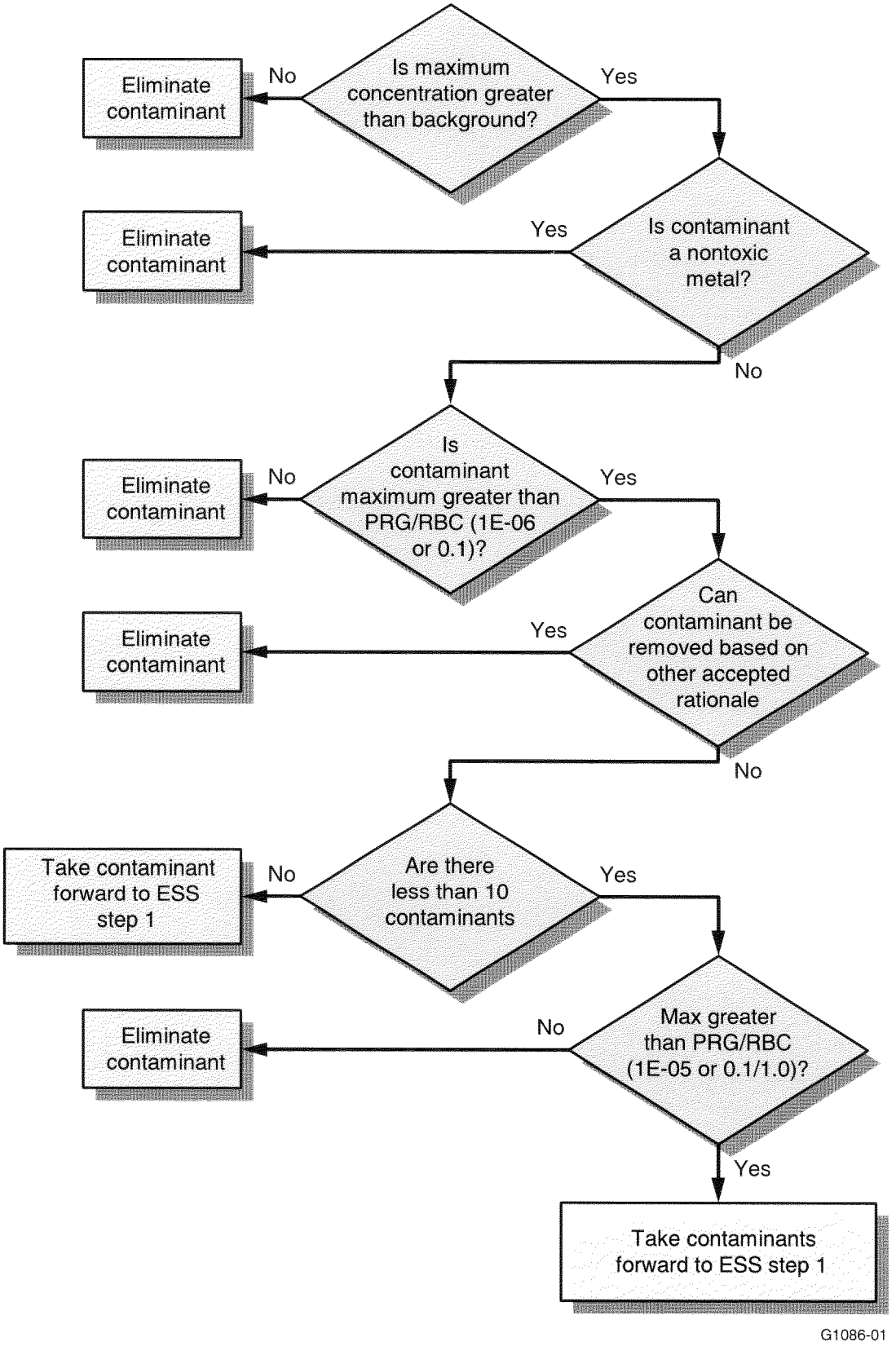

Figure 1. Steps in the initial screening process for human health.

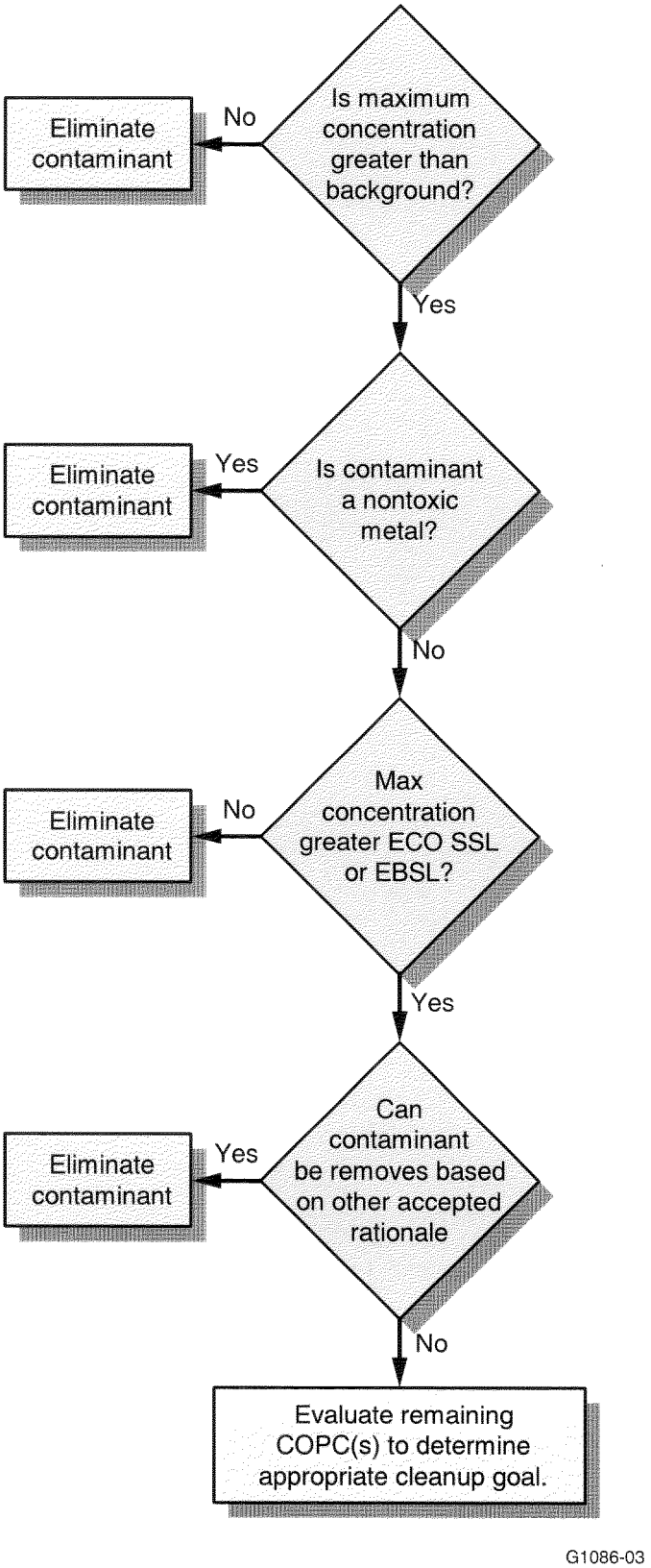

Figure 2. Screening for ecological receptors.

used for comparison because they are more conservative than the background values that were obtained from grab samples. Generally, sampling results from the OU 1-10 site are a combination of both grab and composite samples. Background concentrations for nonradionuclides are found in Table A-2 and radionuclides in Table A-3.

Additional screening can be performed for several metals that had limited analysis in Rood et al. (Rood et al. 1996). This is discussed in detail in Appendix K of the *Comprehensive Remedial Investigation/Feasibility Study Assessment for Waste Area Groups 6 and 10 Operable Unit 10-04* (the OU 10-04 Comprehensive RI/FS) (DOE-ID 2001) and in the footnotes of Table A-2.

4.1.2 IS Step 2: Nontoxic Metal

Step 2 of the human health chemical screening process is elimination of several common nontoxic metals. Site chemicals that are routinely analyzed for but which are not associated with toxicity under normal circumstances include aluminum, calcium, iron, magnesium, potassium, and sodium (Cirone 1991). These should be eliminated from the analysis, unless the concentration is greatly in excess of the background value (i.e., 10 times the background value).

4.1.3 IS Step 3: Risk-Based Concentration Screen (1E-06 and HQ=0.1)

Step 3 in the human health screening process is to compare potential contaminants with the human health risk-based concentration (RBC), also called a preliminary remediation goal (PRG). RBCs are contaminant concentrations in soil, air, and water that correspond to fixed levels of risk (generally either a one-in-one million [10^{-6}] cancer risk or a noncarcinogenic hazard quotient (HQ) of 1). These values are presented in Table A-2 (for nonradionuclides) and Table A-3 (for radionuclides). RBCs that equate to a 10^{-6} cancer risk are indicated by "ca," while RBCs that equate to a hazard quotient for noncarcinogenic concerns are indicated by "nc."

With multiple COPCs it is important to ensure that the sum of the HQs does not exceed 1. Region 3 (EPA 2003b) recommends using one-tenth of the RBC as the basis for contaminant screening. Therefore, the HQs in this screening step are set to 0.1, thereby ensuring that contaminants with additive effects are not prematurely eliminated during screening. However, it is considered acceptable in the contaminant screening process to use the RBC for cancerous contaminants without modification. This is due to the fact that remedial decisions at the INEEL generally are based on the carcinogenic future residential risk level of 1E-04 or a noncarcinogenic hazard quotient of 1. (There is no range of "acceptable" noncarcinogenic "risk," so that under no circumstances should noncancer RBCs be multiplied by 10 or 100, when setting a cleanup value). In other words, if a site's estimated future residential risk exceeds a value of 1E-04, the site typically is considered for remedial action. The 1E-04 risk level is two orders of magnitude greater than the 1E-06 risk level that was used to calculate the RBCs, so the 1E-06 RBCs are adequately protective.

This comparison is conducted for each contaminant measured that survived Screening Steps 1 and 2, as well as detected organic contaminants. If the maximum concentration for a given contaminant is less than or equal to the most conservative RBC, it should be eliminated as a human health issue. The RBCs at this risk level are presented in Table A-2 for nonradionuclides and Table A-3 for radionuclides.

4.1.4 IS Step 4: Elimination of Contaminants Based on Other Rationale

At this step, the contaminants remaining should be evaluated for elimination based on other rationale. These may include several well-accepted reasons to eliminate contaminants from further evaluation. For example, rationale for elimination may include issues with the analysis method used to

assess a contaminant or the accepted background for a metal in the environment. The discussion of arsenic and Ra-226 are included below as examples of the types of concerns that are raised during this stage of the screening.

4.1.4.1 Arsenic. It is accepted that the arsenic background commonly used for risk assessment at the INEEL is generally not applicable to the soil types found surrounding most of the WAGs. This background is provided in the Background Dose Equivalent Rates and Surficial Soil Metal and Radionuclide Concentrations for the INEEL (Rood et al. 1996). Arsenic was evaluated in Rood et al. 1996. As discussed in detail in Appendix K of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001), soil type and soil characteristics found at the INEEL vary greatly, depending on location. Due to sampling issues (as discussed in Appendix K of DOE-ID 2001), Rood et al. (Rood et al. 1996) used only the data from the New Production Reactor (NPR) study to calculate background values for these metals for risk assessment purposes.

The NPR study was conducted to provide site-specific background soil contamination levels of radionuclide and metal concentrations in surface soil for the proposed NPR site on the INEEL (Anderson 1992). A limiting factor with the NPR study was that it only collected soil samples from one soil type—sands over basalt. The background value obtained from this study generally underestimates the concentration of arsenic found in other soil types at the INEEL. The range of arsenic levels in this soil type is not known, but the concentrations of arsenic found in basalt ranged from 0.06–113 ppm with an average of 2 ppm. The average presented in Rood et al. (Rood et al. 1996) for arsenic is 3.8 ppm for this soil type.

Most of TAN is located within deep, alkaline, fine-grained lacustrine sediments from the ancestral Lake Terreton (Olson, Jeppsen, and Lee 1995). These soils were derived from alluvial deposits of the Big Lost River and Birch Creek (Olson et al. 1995). As identified in Table K1-1 of the OU 10-04 Comprehensive RI/FS (DOE-ID 2001), the range of arsenic concentrations from soil with this type of deposition range from 2.1–27.0, with an average 8.2 ppm.

The RBC for arsenic indicates that arsenic is a risk at background. Therefore, after initial screening, an evaluation of the concentration of arsenic and the associated waste stream is made. This evaluation can provide the rationale to eliminate this contaminant from further assessment.

4.1.4.2 Ra-226. The radionuclide Ra-226 can commonly be eliminated from the assessment. First, Ra-226 is a daughter product of naturally occurring U-238 and generally is considered a naturally occurring radioactive material (NORM) and not a product of any known operational discharge at the INEEL. (It is neither a fission byproduct, nor is it an activation product.) There is limited documentation on the background concentrations of radium and other naturally occurring radioactive materials at the INEEL. However, Rood et al. (Rood et al. 1996) presented a summary of radionuclide concentrations for the INEEL. This summary reports a Sitewide U-238 background concentration upper tolerance limit (UTL) of 1.85 pCi/g and 2.15 pCi/g at the 95% and 99% confidence intervals, respectively. The U-238 concentration can be used to estimate Ra-226 concentration for risk estimation since Ra-226 is a naturally occurring radionuclide in the U-238 decay chain, and the activity of the daughter, Ra-226, should be equivalent to that of the parent, U-238.

The concentrations of Ra-226 may also be greater than background in the risk assessment due to issues with the analytical methods. If samples are analyzed using gamma spectrometry, they may be biased high (Giles 1998) and appear to exceed background screening levels. This bias is caused by interference from gamma rays emitted by U-235. Correction of the Ra-226 data can be accomplished by calculating the individual Ra-226 and U-235 contributions to the composite gamma ray peak in the gamma ray spectrum. This calculation is discussed in Giles (1998).

4.1.5 IS Step 5: Risk-Based Concentration Screen (1E-05 and HQ=0.1/1.0)

Step 5 in the human health screening process is to evaluate the number of contaminants that remain after Step 4. If less than 10 contaminants remain after Step 4, it is possible to screen these contaminants against a less stringent level. If the maximum concentration for a given chemical is less than or equal to the RBC at 1E-05 or HQ = 0.1, it can be eliminated as a concern (if less than 10 contaminants remain after Step 3). It is also possible to screen noncancer risk at greater than an HQ of 0.1 if the number of contaminants exceeding the 0.1 level is further evaluated and/or the mechanisms of toxicity are examined. Basing the HHRA PRGs for noncancer risk initially on an HQ of 0.1 ensures an additional level of conservatism. This additional conservatism ensures that multiple COPCs do not pass a screening possibly contributing a greater total HQ than 1.0. This is an important point that should not be overlooked during this process. However, justification should be included in the assessment. RBCs at this risk level are presented in Table A-4 for nonradionuclides and Table A-5 for radionuclides.

4.2 Ecological Screening

The same data set compiled for the human health chemical screening was used to identify COPCs to be further evaluated (see Figure 2). The screening steps to identify ecological COPCs are described below.

4.2.1 ECO Step 1: Background Comparison

As performed in the human health chemical screening, the first step in the ecological screening process is to distinguish potential contamination associated with the site from naturally occurring background conditions. The comparison is primarily conducted using the composite background values from Rood et al. (Rood et al. 1996) or from other sources, as identified.

4.2.2 ECO Step 2: Nontoxic Metal

Step 2 of the ecological screening process is a nontoxic metal screening analysis. As performed in the HHRA, site chemicals that are considered nontoxic are not evaluated further unless the concentration is greatly in excess of the background value (10 times). The six metals routinely eliminated by this screening step are aluminum, calcium, iron, magnesium, potassium, and sodium (Cirone 1991).

4.2.3 ECO Step 3: Comparison of Maximum Concentration to Ecologically Based Screening Level

For the remaining chemicals, the third step in the ecological chemical screening process is to compare potential contaminants associated with the site with EBSLs or EPA Region 4 ecological SSLs. If the maximum concentration for a given chemical is greater than or equal to the most conservative EBSL, the chemical is retained for further evaluation. The EBSLs used for the screening are consistent with the INEEL-wide screening levels and are presented in Table A-6. Details for EBSL development and EBSL values are documented in Appendix D2 of the *Workplan for Waste Area Group 6 & 10 Operable Unit 10-04 Comprehensive Remedial Investigation Feasibility Study* (DOE-ID 1999b).

4.2.4 ECO Step 4: Elimination of Contaminants Based on Other Rationale

Typically, several contaminants are not eliminated during the first three steps of this process that should not be taken forward further in the risk assessment. Several issues with contaminant concentrations are frequently a problem during sampling at sites of concern at the INEEL that generally are addressed by discussion in the initial screening process. The discussion of arsenic and Ra-226 presented in Section 4.1 are examples.

4.2.5 ECO Step 5: Development of SLQs and TSLQs

A screening level quotient (SLQ) can be developed that is similar to a hazard quotient (HQ). This quotient is developed by dividing the concentration of the contaminant by its EBSL. All the SLQs are summed to develop a total screening level quotient (TSLQ). If the TSLQ does not exceed 10, then the contaminants remaining can be eliminated. If the TSLQ exceeds 10, then an individual evaluation of each contaminant, using risk assessment methods as discussed in the OU 10-04 Comprehensive RI/FS (DOE-ID 2001), will be required.

5. EXPOSURE SCENARIO BASED SCREENING PROCESS

For any contaminant that comes forward from the initial contaminant screening, it is then possible to screen using an exposure scenario specific approach. As discussed in the OU 1-10 Comprehensive RI/FS (DOE-ID 1997), the INEEL has used a consistent approach to performing HHRAs at potential release sites. This approach is documented in the OU 1-10 Comprehensive RI/FS (DOE-ID 1997) and is adapted to assess the pre-remediation and closure soil sampling at WAG 1.

The risk assessment approach identifies and characterizes potentially exposed populations and traces the exposure pathways from the site to the exposed populations. Each exposure pathway describes a mechanism by which a population or individual could be exposed to contaminants originating from the release site. Only those exposure pathways deemed to be complete (i.e., where a plausible route of exposure can be demonstrated from the site to the receptor) are evaluated in the risk assessment. The contaminant source (by depth), the release mechanism, the exposure pathway, exposure route, and receptor are summarized in the conceptual site models (CSMs). The CSM for the current occupational scenario is presented in Figure 3 and the future residential scenario is presented in Figure 4.

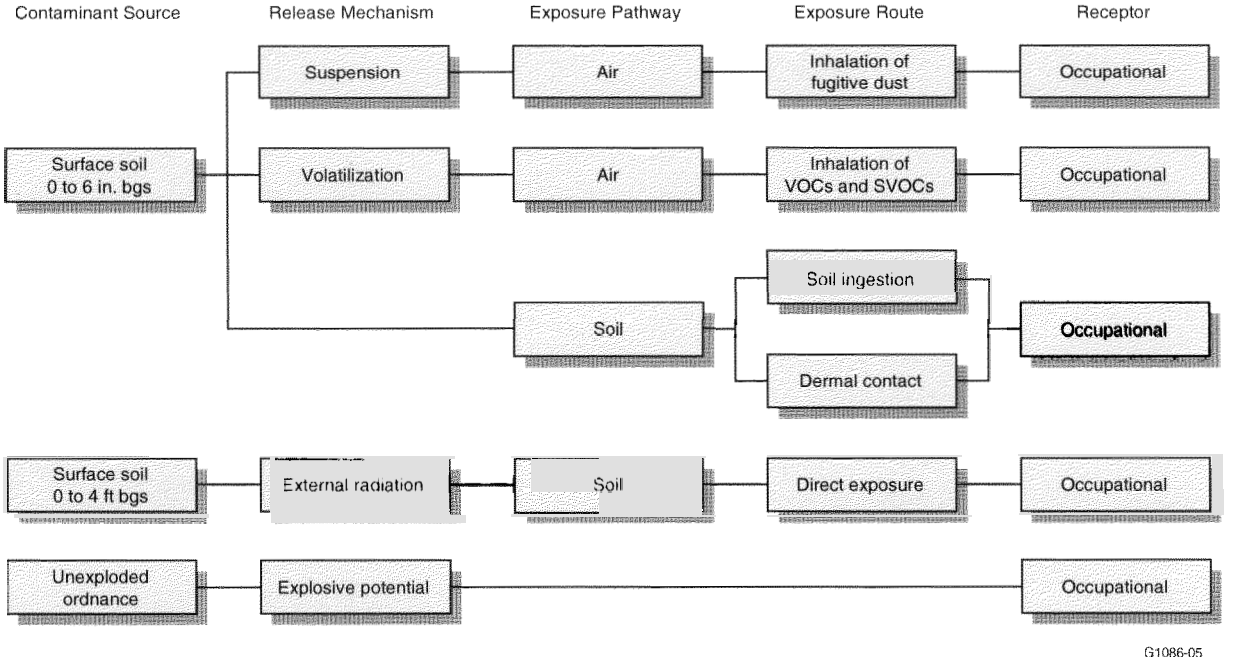

Figure 3. Conceptual site model for the occupational worker.

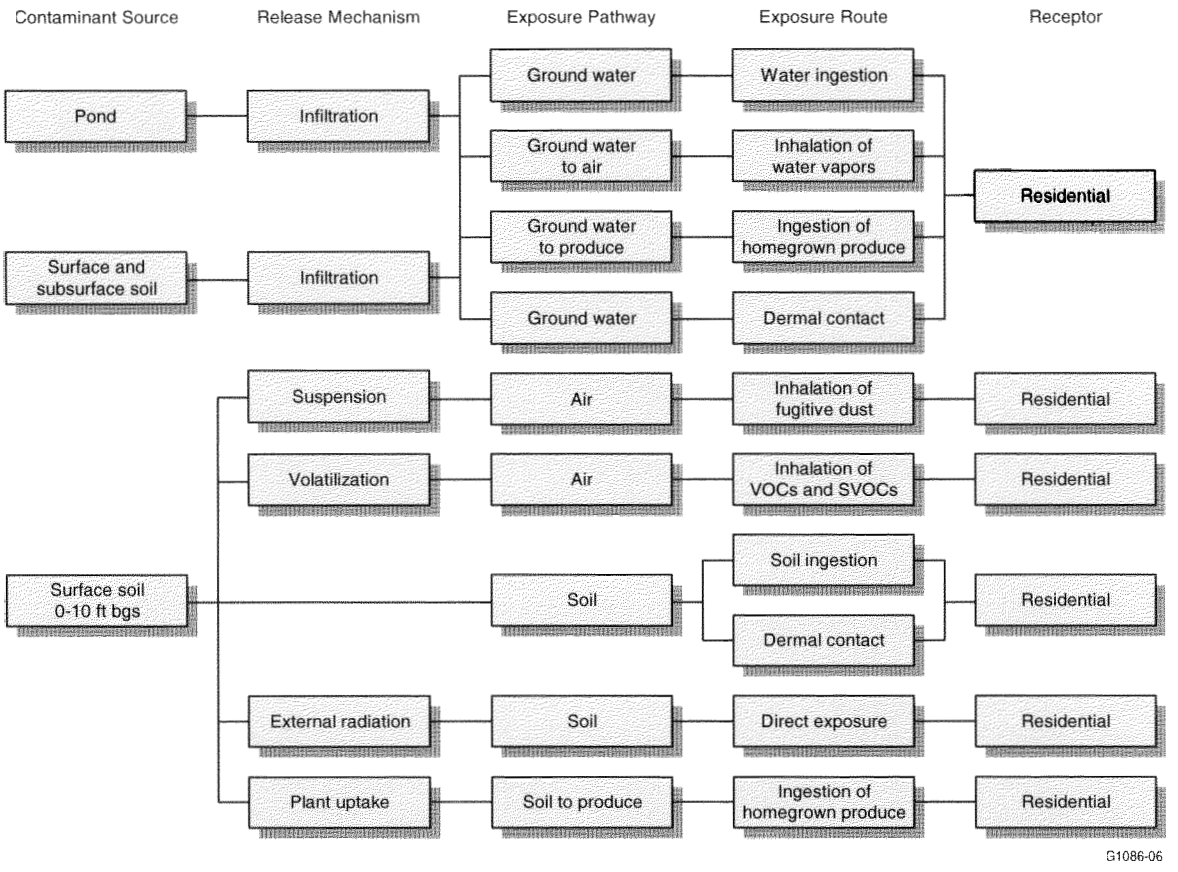

Figure 4. Conceptual site model for residential intrusional scenarios.

In general, the CSM exposure routes are consistent with the INEEL Track 2 Guidance, *Track 2 Sites: Guidance for Assessing Low Probability Hazard Sites at the INEL* (DOE-ID 1994), with some exceptions. The risks from the ingestion of contaminated homegrown produce and dermal exposure to contamination are included. These exposure routes are not covered by the INEEL Track 2 Guidance, but were evaluated to be consistent with other WAG assessments. Sites at WAG 1 require the evaluation of the current occupational as well as the future residential scenario (used in the initial RI/FS assessment). Although, most of the sites will remain under institutional controls for the next 100 years and residential living will not be permitted, workers that are currently housed within this area could be exposed. Therefore, it is necessary to consider this group of receptors. The following steps should be performed for the Exposure Scenario Based Screening (ESS) and are presented in Figure 5 for nonradionuclides and Figure 6 for radionuclides.

The Region 9 RBCs include inhalation of volatiles in both the residential and industrial land-use exposure pathways. Volatile chemicals are defined as having a Henry's Law constant greater than 10^{-5} atm-m^3/mol and a molecular weight less than 200 g/mole. The models used to calculate RBCs for inhalation of volatiles are updates of risk assessment methods presented in the Risk Assessment Guidance (RAG) Part B (EPA 1991) and are identical to the Soil Screening Guidance: User's Guide and Technical Background Document (EPA 1996 a, b). The evaluation of the soil-to-air pathway is based on inhalation exposure that results from the volatilization of chemicals from soil-to-outdoor air. The Region 9 RBCs do not currently evaluate potential for volatile contaminates in soil to migrate indoors. This evaluation requires a site-specific assessment such as the Johnson and Ettinger model (Johnson and Ettinger 1991). In the past 10 years, this has become acknowledged as an important pathway and any chemicals with

these characteristics should be evaluated qualitatively based on the scenario of concern, the size of the area of contamination, and the concentrations. A quantitative assessment will be performed only if deemed necessary. Any quantitative assessment should use the Johnson and Ettinger model or a similar approach to assess this risk.

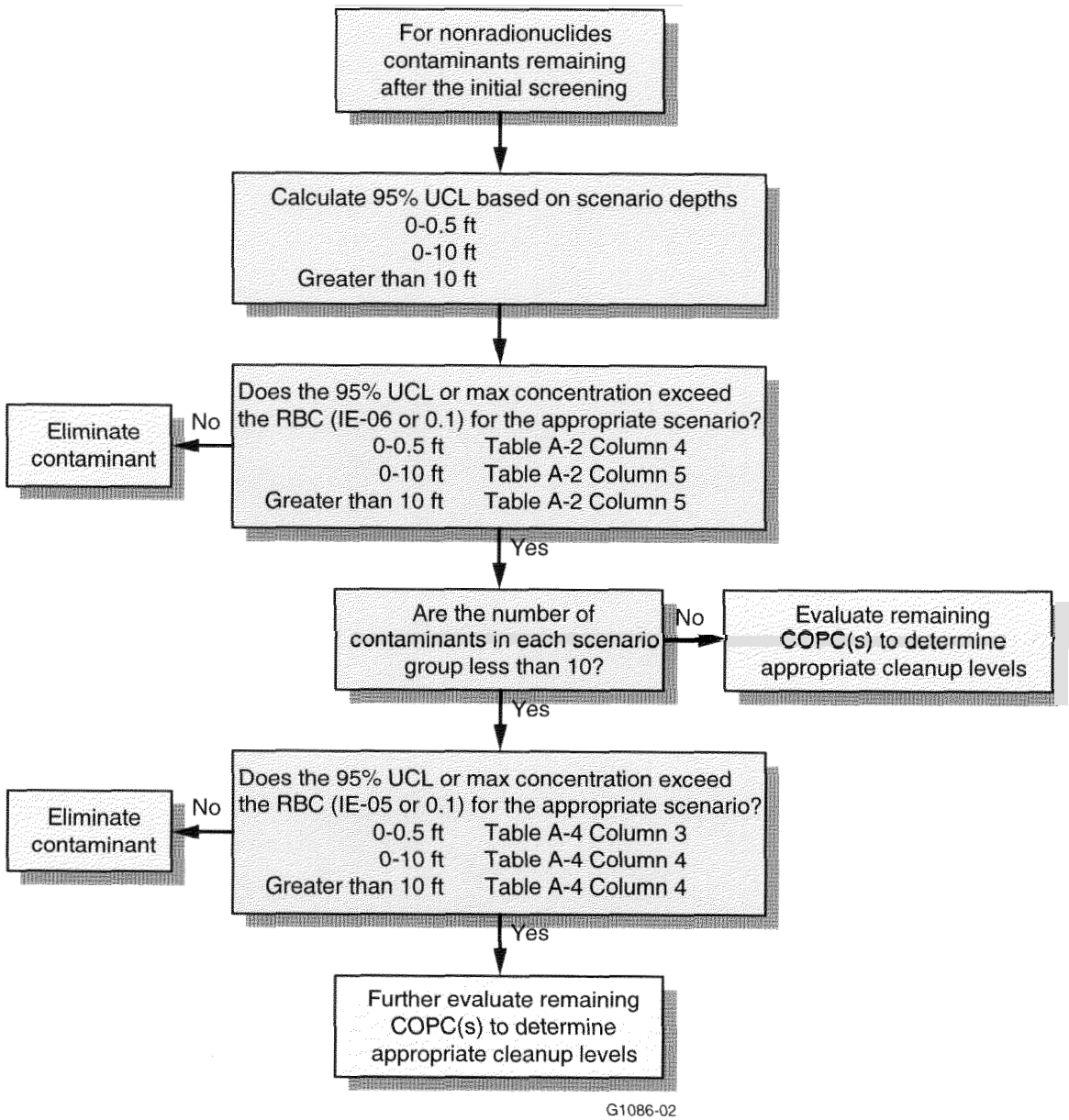

Figure 5. Human health exposure scenario screening steps for metals.

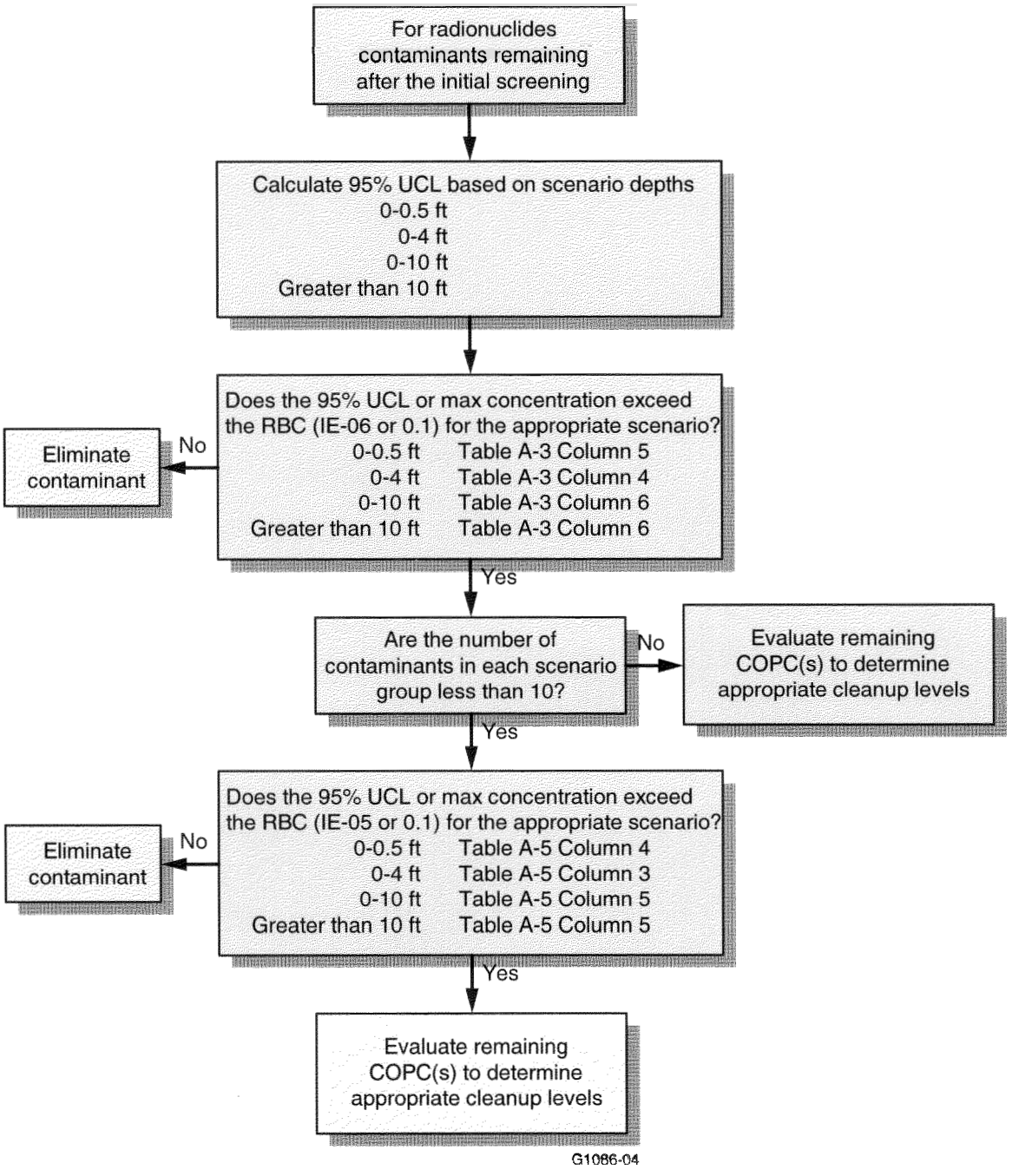

Figure 6. Human health exposure screening steps for radionuclides.

5.1 ESS Step 1 Calculate 95% UCL Based on Scenario Depths

The depths of contamination used to evaluate the scenarios and exposure routes discussed in the following sections are based on guidance given in the INEL Track-2 Investigation Manual (DOE-ID 1994). For quantitative assessment, in the baseline risk assessment contaminant concentrations are based on the 95% upper confidence limit (UCL) of the mean concentrations (or maximum concentration if the maximum is less than the 95% UCL) of samples collected over the following depth ranges:

Depth	Exposure Route(s)
0 to 0.2 m (0 to 6 in.)	HHRA occupational scenario: soil ingestion, inhalation of fugitive dust, inhalation of volatiles
0 to 1.2 m (0 to 4 ft)	HHRA occupational scenario: external radiation exposure
0 to 3 m (0 to 10 ft)	HHRA residential scenario: all soil pathway and air pathway exposure routes; ecological risk assessment
All sample results included, regardless of depth	HHRA residential scenario: all groundwater pathway exposure routes

For each soil depth outlined in Section 4, the 95% UCL for each detected contaminant can be calculated as discussed in "Supplemental Guidance to RAGS: Calculating the Concentration Term" (EPA 1992).

5.2 ESS Step 2: Exposure Scenario Screen (Occupational and Future Residential Scenarios [1E-06 and HQ = 0.1])

Step 2 in the exposure scenario screening process evaluates the contaminants that remain after the initial screening process discussed in Section 4. This screening step evaluates contaminants based on each exposure scenario and the extent of detection in the soil. The calculated 95% UCL for each contaminant may then be compared against the exposure scenario RBCs (at 1E-06 and HQ = 0.1) and the corresponding soil depth (listed in Tables A-2 and A-3). Contaminants detected at the various soil depths may then be eliminated (based on exposure scenarios) if concentrations are less than the corresponding RBCs. If more than 10 contaminants still remain (following this step) within the same soil depth and fall under the same exposure scenario, then those contaminants would need further evaluation. If less than 10 contaminants remain, then proceed to ESS Step 3.

5.3 ESS Step 3: Exposure Scenario Screen (Occupational and Future Residential Scenarios [1E-05 and HQ = 0.1])

Step 3 in the exposure scenario human health screening process is to evaluate the contaminants that remain following Step 2. Because less than 10 contaminants remain, it is possible to screen these contaminants against a less stringent risk level. The calculated 95% UCL for each contaminant, for the various soil depths, may then be compared against the exposure scenario RBC (1E-05 and HQ = 0.1) and the corresponding soil depth (listed in Tables A-4 and A-5). Contaminants detected at the various soil depths may then be eliminated (based on exposure scenarios), if concentrations are less than the corresponding RBC. If any contaminants still remain following this step, then those contaminants would need further evaluation.

If less than 10 contaminants remain at this step, it is possible to screen these contaminants against a less stringent level. If the maximum concentration for a given chemical is less than or equal to the RBC at 1E-05 or HQ = 0.1, it can be eliminated as a concern (if less than 10 contaminants remain after Step 3). It is also possible to screen noncancer risk at greater than an HQ of 0.1 if the number of contaminants exceeding the 0.1 level is further evaluated and/or the mechanisms of toxicity are examined. Basing the HHRA RBCs for noncancer risk initially on an HQ of 0.1 ensures an additional level of conservatism. This additional conservatism ensures that multiple COPCs do not pass a screening while contributing a greater total HQ than 1.0. This is an important point that should not be overlooked during this process. However, justification should be included in the assessment.

6. GROUNDWATER PATHWAY EXPOSURE

As discussed in the OU 1-10 Comprehensive RI/FS (DOE-ID 1997) and the OU 1-10 ROD (DOE-ID 1999a), Cs-137 is not a risk driver considered at greater than 10 ft depth. However, every contaminant that is not eliminated by the contaminant screening process is assumed to have the potential for migrating to groundwater. As discussed, risks to receptors at the INEEL are evaluated by contaminant depth based on exposure scenarios (DOE-ID 1994, DOE-ID 1997). The current occupational worker evaluates at the 0 to 0.2 m (0 to 6 in.) depth for soil ingestion, inhalation of fugitive dust and volatiles. The occupational worker also evaluates at the 0 to 1.2 m (0 to 4 ft) range for external radiation exposure. The future residential scenario evaluates at the 0 to 3 m (0 to 10 ft) range for all soil and air pathways. This depth range is also used to assess ecological risk. All sample results, regardless of depth, are used in the human health future residential scenario to evaluate the groundwater pathway exposure routes. Soil located greater than 3 m (10 ft) below ground is assumed to expose a human receptor only through the groundwater pathway since contamination located at this depth may migrate through the soil column to the aquifer located beneath the site. Soil located greater than 3 m (10 ft) below the ground are not considered to be an issue for ecological receptors since at this site there is no pathway. Groundwater pathway risks are calculated at 100 years in the future for use in the 100-year residential exposure scenario.

Groundwater concentrations resulting from surface and near-surface sources are estimated using the computer code GWSCREEN (Rood 1998). For each COPC, GWSCREEN produces groundwater concentrations versus time as the codes output. From this output, the maximum 30-year average groundwater concentration of each COPC and the 30-year average concentrations at 100 years in the future are calculated. The average concentrations at year 100 are used to calculate groundwater pathway risks for the 100-year residential exposure scenario, and the maximum average concentrations are used to calculate maximum expected groundwater risks.

The total mass of each contaminant considered in the GWSCREEN modeling is calculated by summing the contaminant masses from the retained sites and must be assessed cumulatively across WAG 1. The contaminant mass at each retained site is derived by multiplying the contaminant's 95% UCL of the mean concentration (or maximum concentration if the maximum is less than the 95% UCL) by the mass of contaminated soil at the site. For example, if a contaminant has a 95% UCL of the mean concentration of 5 mg/kg at three release sites with dimensions of $10 \times 10 \times 1$ m ($30 \times 30 \times 3$ ft), the mass of the contaminant that would be used in the GWSCREEN modeling would be 2.3E+06 mg [(3 sites) $\times$ (5 mg/kg/site) $\times$ (10 m) $\times$ (10 m) $\times$ (1 m) $\times$ (1E+06 cm^3/m^3) $\times$ (1.5 g/cm^3) $\times$ (1E–03 kg/g) = 2.3E+06 mg]. Information about how GWSCREEN calculates groundwater concentrations is included in the Track 2 Guidance (DOE-ID 1994). EPA Region 9 does provide SSLs for migration to groundwater and residential and industrial soils, which should be evaluated for those contaminants below 10 ft.

Although the EPA Region 9 RBCs for residential and industrial soils nonradionuclides are not developed specifically to be protective of groundwater, they are accepted at the INEEL as being conservative enough for screening, given the approach presented in this report. If a contaminant is not eliminated by the screening process then it will be necessary to evaluate this contaminant using standard risk-assessment methods, as discussed in the OU 1-10 Comprehensive RI/FS (DOE-ID 1997).

The memorandum from Jeff Fromm (Fromm 1996) does not include radionuclide RBCs for the groundwater migration pathway. However, (based on Track 2 Guidance) given the depth to groundwater and the low infiltration rate at the INEEL, radionuclides with a half-life of less than 100 years would generally pose a significant risk from other exposure pathways before potential groundwater contamination would be the exposure route that would drive cleanup efforts (DOE-ID 1994). For longer-lived radionuclides, the EPA SSLs will be used (EPA 1996a). Soil screening levels were

developed to identify concentrations in soil that are protective of groundwater and they are back-calculated from acceptable groundwater concentrations (i.e. maximum contaminant level goals [MCLGs], maximum contaminant levels [MCLs], or risk-based PRGs). These SSLs are considered fairly conservative for the INEEL and it may be necessary to further develop site-specific SSLs to obtain realistic cleanup levels. Methodologies for developing SSLs are based on conservative, simplifying assumptions about the release and transport of contaminants to the subsurface (EPA 2002). Any SSL derived from equations will combine exposure information assumptions with EPA radiotoxicity data. The methodology is outlined in the "Soil Screening Guidance for Radionuclides: User's Guide" (EPA 1996b).

7. EXAMPLE

Tables 2 and 3 present an example of the first several screening steps. Table 2 presents the screening of 1 organic, 17 metals, and 10 radionuclides. In Initial Soil Screening/Ecological Screening (IS/ECO) Step 1, 7 metals and 2 radionuclides are eliminated since the maximum concentration detected does not exceed the INEEL background. IS/ECO Step 2 in Table 2 then eliminates aluminum, calcium, magnesium, and sodium as nontoxic essential metals. The IS and ECO Step(s) 3 in Table 2 present an example of the RBC screen used for both human and ecological receptors. Using the most conservative level (1E-06 or 0.1) RBC for a screen, all but chromium, thallium, Co-60, and U-235 are eliminated for HHRA; and all but chromium, selenium and thallium are eliminated for ecological receptors. As part of the IS/ECO Step 4, it is important to evaluate other rationale for elimination of COPCs as a concern. This eliminates unnecessary cleanup. In this example, the rationale is included in the footnotes of Table 2. Here both arsenic and Ra-226 are eliminated based on the rationale presented in Section 4.1 and reiterated in the footnote of Table 2. In summary, of the 28 total contaminants detected in this example, all but 5 were eliminated (3 metals and 2 radionculides). Since there are less than 10 contaminants total, the screening can move to IS Step 5. If more than 10 contaminants were identified, it would be necessary to go to ESS Step 1 while maintaining the COPCs identified as a concern for ecological receptors for final determination of appropriate cleanup levels.

Table 3 continues this example using ECO Step 5 and ISS Step 5. For ISS Step 5, an additional screen with less conservative RBCs is performed. The COPCs for ecological receptors are also brought forward. ISS Step 5 eliminates chromium, thallium and U-235 as a concern for human receptors. For ECO Step 5, SLQs are developed that allow us to eliminate both selenium and thallium. In summary, as a result of this step of the screening, Co-60 remains for human health concerns and chromium for ecological concerns. However, in evaluating chromium, it could be eliminated as an ecological concern. First, it is less than 7% over background. In addition, the relationship of this value to others collected within the area would need to be evaluated. Finally, the 95% UCL can be qualitatively compared to this value.

The next human health screen evaluates the 95% UCL of the concentration to the RBCs by depth. This cannot be performed if insufficient samples have been collected. In this example, there were insufficient samples and as a result the maximum was less than the 95% UCL. The samples were collected in the 3-ft range and therefore can be used for all except the 0-0.2 m occupational scenario. Table 4 continues our example with ESS Step 2 (Step 1 was not necessary, since only 1 COPC was assessed). As can be seen from the results of Step 2, the driver for risk is the occupational worker. Since cleanup is performed at the INEEL to the 1E-04 risk level for the 100-year residential scenario, Co-60 does not require cleanup; however, controls must be put in place to ensure workers are protected (from external exposure) until this radionuclide has decayed (half-life is 5 years).

Table 2. Data used for Steps 1-4 of the initial soil contaminant screening process.

		IS/ECO - Step 1		IS/ECO - Step 2	IS - Step 3		ECO – Step 3		Site COPC at First Screening	
Detected Contaminants	Max Source Concentration (mg/kg or pCi/g)	Background Concentration (mg/kg or pCi/g)	Max Concentration> Background?	Nontoxic Metal?	RBC for 1E-06 or HQ>0.1 RBC (mg/kg or pCi/g)	Max Concentration > RBC?	INEEL EBSL (mg/kg or pCi/g)	Max Concentration > EBSL?	HHRA	ECO
1,2,4-Trichlorobenzene	3.60E-01	NA	NA	No	6.50E+01	No	1.82E+00	No	No	No
Aluminum	1.66E+04	1.60E+04	Yes	Yes	7.60E+03	Yes	5.00E+01	Yes	No	No
Antimony	8.42E-01	4.80E+00	No	No	3.10E+00	No	3.50E+00	No	No	No
Arsenic[a]	1.67E+01	5.80E+00	Yes	No	3.90E-01	Yes	1.00E+01	Yes	No[a]	No[a]
Cadmium	1.04E+00	2.20E+00	No	No	3.70E+00	No	1.60E+00	No	No	No
Calcium	1.12E+05	2.40E+04	Yes	Yes	3.70E+01	Yes	No EBSL	No EBSL	No	No
Chromium	3.53E+01	3.30E+01	Yes	No	3.00E+01	Yes	1.00E+00	Yes	Yes	Yes
Cobalt	9.36E+00	1.10E+01	No	No	9.00E+02	No	4.00E+01	No	No	No
Iron	2.20E+04	2.40E+04	No	Yes	3.70E+01	Yes	2.00E+02	Yes	No	No
Lead	2.38E+01	1.70E+01	Yes	No	4.00E+01	No	5.00E+01	No	No	No
Magnesium	1.41E+04	1.20E+04	Yes	Yes	3.70E+01	Yes	No EBSL	No EBSL	No	No
Manganese	4.58E+02	4.90E+02	No	No	1.60E+03	No	1.00E+02	Yes	No	No
Mercury	1.26E-01	5.00E-02	Yes	No	2.30E+00	No	3.00E-01	No	No	No
Potassium	2.73E+03	4.30E+03	No	Yes	NO RBC	No RBC	No EBSL	No EBSL	No	No
Selenium	1.47E+00	2.20E-01	Yes	No	3.90E+01	No	8.10E-01	Yes	No	Yes
Silver	4.25E-01	NA	No	No	3.91E+01	No	2.00E+00	No	No	No
Sodium	1.26E+03	3.20E+02	Yes	Yes	NO RBC	No RBC	No EBSL	No EBSL	No	No
Thallium	1.05E+00	4.30E-01	Yes	No	5.20E-01	Yes	1.00E+00	Yes	Yes	Yes

Table 2. (continued).

		IS/ECO - Step 1		IS/ECO - Step 2	IS - Step 3		ECO – Step 3		Site COPC at First Screening	
Detected Contaminants	Max Source Concentration (mg/kg or pCi/g)	Background Concentration (mg/kg or pCi/g)	Max Concentration> Background?	Nontoxic Metal?	RBC for 1E-06 or HQ>0.1 RBC (mg/kg or pCi/g)	Max Concentration > RBC?	INEEL EBSL (mg/kg or pCi/g)	Max Concentration > EBSL?	HHRA	ECO
Co-60	1.16E-01	NA	NA	No	7.20E-02	Yes	1.18E+03	No	Yes	No
Cs-137	6.25E+00	8.20E-01	Yes	No	2.30E+01	No	4.95E+03	No	No	No
H-3	2.85E+01	NA	NA	No	8.80E+04	No	3.43E+05	No	No	No
K-40	1.83E+01	2.40E+01	No	No	5.70E-02	Yes	No EBSL	No	No	No
Ni-63	1.64E+01	NA	NA	No	3.20E+03	No	No EBSL	No	No	No
Ra-226[b]	1.02E+00	NA	NA	No	5.50E-03	Yes	2.04E+01	No	No[b]	No
Sr-90	2.70E+00	4.90E-01	Yes	No	7.80E+01	No	3.34E+03	No	No	No
U-234	4.86E+00	1.44E+00	Yes	No	1.80E+01	No	2.05E+01	No	No	No
U-235	5.92E-01	NA	NA	No	1.30E-01	Yes	2.27E+01	No	Yes	No
U-238	1.12E+00	1.40E+00	No	No	6.70E-01	Yes	2.32E+01	No	No	No

STEP 4: Elimination of contamination based on other rational.

a. Arsenic is eliminated as a contaminant of concern since the maximum value is within limits of regional background for soils of this origin (see discussion in text) and it is not in the known waste streams at this site.

b. Ra-226 is eliminated as a contaminant of concern based on the discussion presented in Section 4. Ra-226 is not in the waste streams at this site; it is a naturally occurring radionuclide in the environment and when corrected for interference should be within regional background values.

NOTES: "NA" in Step 1 indicates that a background value is not available.
"No RBC" indicates that an EPA Region 9 or 3 risk-based concentration is not available.
"No EBSL" indicates that an INEEL ecologically-based screening level is not available.

Table 3. Data used for Ecological Screening Step 5 and Initial Screening Step 5 of the screening process.

Detected Contaminants	Max Source Concentration (mg/kg or pCi/g)	IS - Step 5 RBC for 1E-05 or HQ>1RBC (mg/kg or pCi/g)	IS - Step 5 Max Concentration > RBC?	ECO-Step 4 SLQ	ECO-Step 4 HHRA	ECO-Step 4 ECO
Chromium	3.53E+01	3.00E+02	No	35.3	No	Yes
Selenium	1.47E+00	3.90E+01	No	1.81	No	No
Thallium	1.05E+00	5.20E-01	No	1.05	No	No
Co-60	1.60E+00	7.20E-01	Yes	NA	Yes	No
U-235	5.92E-01	1.30E+00	No	NA	No	No

NOTE: "NA" indicates that no screening level quotient calculation was required.

Table 4. Data used for Exposure Scenario Based Screening Step 2 of the screening process for Co-60.

Depth Range	95% UCL or Maximum by Depth	Occupational RBC (1E-05) (see Table A-3 Column 5)	Concentration Exceeds RBC	Occupational RBC (1E-05) (see Table A-3 Column 4)	Concentration Exceeds RBC	100-year Residential RBC (1E-05) (see Table A-3 Column 6)	Concentration Exceeds RBC
0 to 0.2 m	1.6E+00	6.6E+03	No	7.2E-01	NA	7.4E+04	NA
0 to 1.2 m	1.6E+00	6.6E+03	NA	7.2E-01	Yes	7.4E+04	NA
0 to 3 m	1.6E+00	6.6E+03	NA	7.2E-01	NA	7.4E+04	No
Greater than 3 m	NA	6.6E+03	NA	7.2E-01	NA	7.4E+04	NA (no values below 3 m)

NOTE: "NA" indicates that this scenario was not assessed or could not be assessed for this scenario.

8. DEVELOPMENT OF CLEANUP LEVELS

The RBCs and PRGs developed for the CERCLA/RCRA programs are risk-based concentrations, derived from standardized equations, combining exposure information assumptions with EPA toxicity data. They are considered by the EPA to be protective for humans (including sensitive groups) over a lifetime. The RBC's role in site "screening" is to help identify areas, contaminants, and conditions that do not require further federal attention at a particular site. Generally, at sites where contaminant concentrations fall below RBCs, no further action or study is warranted under the CERCLA program so long as the exposure assumptions at a site match those taken into account by the RBC calculations. Chemical concentrations above the RBC would not automatically designate a site as "dirty" or trigger a response action. However, exceeding an RBC suggests that further evaluation of the potential risks that may be posed by site contaminants is appropriate.

Risk-based concentrations are also useful tools for identifying initial cleanup goals at a site. In this role, RBCs provide long-term targets to use during the analysis of different remedial alternatives. By developing RBCs early in the decision-making process, design staff may be able to streamline the consideration of remedial alternatives. However, RBCs are not always applicable to a particular site and do not address nonhuman health endpoints such as ecological impacts.

The PRGs or RBCs for human health used in this evaluation are generic; that is, they are calculated without site-specific information. They may be recalculated using site-specific data. The site-specific EBSLs do include site-specific information, however, they are very conservative. It is accepted at the INEEL to use cleanup levels at the 1E-04 level and/or HI of 1 based on the future residential scenario, and an HI of 10 for ecological receptors, as documented in the OU 1-10 ROD (DOE-ID 1999). PRGs or RBCs are not considered *de facto* cleanup standards; however, they can be used to establish final cleanup levels for a site after a proper evaluation takes place. These HHRA and ecological scenarios are appropriate to use for developing cleanup levels for use at WAG 1 sites during remediation. However, the following guidelines must be used to ensure conservative cleanup levels that will be protective of both human and ecological receptors.

It is necessary to be aware of the impacts from multiple contaminants (as well as the presence of Cs-137) and the locations and number of the samples taken. The cleanup goals are established for multiple contaminants by ensuring that in total they do not exceed 1E-04 and/or HI of 1.0. This screening approach is developed to address multiple contaminants, and this concern needs to be addressed during the development of cleanup levels. If there are less than 10 contaminants that exceed the screening, then use of the 1E-05 and HI of 0.1 may be appropriate, given the assumption that not all the contaminants will have the same mechanism of injury, and therefore the HI of 0.1 should be protective. The alternative is to regroup contaminants based on mechanism of injury; then it may be appropriate to use a less conservative cleanup level (as in the example above). If Cs-137 is present, consideration of cleanup levels for other COPCs must address that the FRG for Cs-137 was established based on a RBC for 1E-04 risk to the future resident. If Cs-137 is present, the establishment of a cleanup level for another contaminant must take into consideration the contribution of Cs-137 for total risk.

In addition, all sampling results should be adequately assessed to ensure that additional cleanup is required. It may be cost efficient to do some additional assessment (either sampling or analysis) to determine whether the risk shown in the screening is real, or if the cleanup levels can be reduced. Additionally, institutional controls (similar to those established in the OU 1-10 RI/FS [DOE-ID 1997]) could be proposed as a remedy.

Each site will be evaluated individually and a risk-based assessment report with the decisions and cleanup levels selected will be prepared.

9. SUMMARY AND REPORTING

Risk-based concentrations can be used in screening for both human and ecological risk. The initial screening evaluates the maximum COPC against background and the RBCs or EBSL/ecological SSLs for all scenarios at different risk levels. For those contaminants not eliminated in this initial screening process, an additional scenario-based screening can be performed using the 95% UCL contaminant concentration by depth. This screening evaluates the 95% UCL against the lowest RBC for the scenario associated with that depth at different risk levels. Any contaminant that exceeds either the human or ecological risk assessment screenings may need to be further evaluated to determine if any action is required. If appropriate, a cleanup level can be determined using the RBCs as a basis.

A risk-based assessment report will be prepared to document the results of the risk-based screening assessment, the cleanup level determination, and subsequent remediation decision. This report will be a brief report provided to the EPA, Idaho Department of Environmental Quality, and the U.S. Department of Energy Idaho Operations Office (collectively referred to as the "Agencies") for review. The outline of the report will be as follows:

- Introduction – Provide purpose and identify sites that are covered in the report.
- Sampling Activities and Results – This section will provide a brief overview of the sample collection activity directing the reader to those documents providing more detailed information.
- Initial Screening – This section will provide a summary of the results of the first level of screening for human and ecological health. This section will include the rationale for additional screening as discussed in Section 7. Tables presenting the screening of all contaminants will be presented in an Attachment.
- Exposure Scenario Screening – Results of the exposure scenario screening will be presented in this section. The development of 95% UCLs will be presented as an attachment. Any contaminant concentrations of concern below 10 ft will also be presented in this section. The baseline exposure scenario assessed is for unrestricted use by future residents (100-yr residential). The current occupational scenario will be included if future residential use is not anticipated.
- Additional Assessment – This section will only be included if deemed necessary. This section will allow an additional assessment or sensitivity study to be presented that may address a COPC that has exceeded the screening.
- Development of Cleanup Levels – This section will only be included if deemed necessary. This section will discuss the development of a cleanup level for any contaminant identified.
- Summary – This section will briefly provide an overview and results.

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Appendix A

Tables

Table A-1. Identified contaminants of concern.[a]

Organic COPCs	Organic COPCs (continued)	Organic COPCs (continued)	Inorganic COPCs	Radionuclide COPCs
1,1-dichloroethane	Acenaphthene	Dibenz(a,h)anthracene	Aluminum	Ag-108m
1,1-dichloroethene	Acenapthylene	Dibenzofuran	Antimony	Ag-110m
1,1,1-trichloroethane	Acetone	Dibromochloromethane	Arsenic	Am-241
1,1,2-trichloroethane	Anthracene	Dibutylphthalate	Barium	Ce-144
1,1,2,2-tetrachloroethane	Aroclor-1016	Diethylphthalate	Beryllium	Cm-242
1,2-dichlorobenzene	Aroclor-1221	Dimethylphthalate	Boron	Cm-243/244
1,2-dichloroethane	Aroclor-1232	Di-n-octylphthalate	Cadmium	Co-58
1,2-dichloroethylene	Aroclor-1242	Ethylbenzene	Chromium	Co-60
1,2-dichloropropane	Aroclor-1248	Fluoranthene	Cobalt	Cs-134
1,2,4-trichlorobenzene	Aroclor-1254	Fluorene	Copper	Cs-137
1,3-dichlorobenzene	Aroclor-1260	Hexachlorobenzene	Iron	Eu-152
1,3-dichloropropene (cis)	Benzene	Hexachlorobutadiene	Lead	Eu-154
1,3-dichloropropene (trans)	Benzo(a)anthracene	Hexachlorocyclopentadiene	Magnesium	Eu-155
1,4-dichlorobenzene	Benzo(a)pyrene	Hexachloroethane	Manganese	H-3
1,4-dioxane	Benzo(b)fluoranthene	Indeno(1,2,3-cd)pyrene	Mercury	I-129
2-butanone	Benzo(g,h,i)perylene	Isophorone	Nickel	Mn-54
2-chloronaphthalene	Benzo(k)fluoranthene	Methylene chloride	Selenium	Nb-95
2-chlorophenol	Benzoic acid	N-nitroso-di-n-propylamine	Silver	Ni-63
2-hexanone	Benzyl alcohol	N-nitrosodiphenylamine	Thallium	Np-237
2-methylnaphthalene	Bis(2-chloroethoxy)methane	Naphthalene	Tin	Pu-238
2-methylphenol	Bis(2-chloroethyl)ether	Nitrobenzene	Vanadium	Pu-239/240
2-nitroaniline	Bis(2-chloroisopropyl)ether	Pentachlorophenol	Zinc	Ra-226
2-nitrophenol	Bis(2-ethylhexyl)phthalate	Phenanthrene		Ru-103

Table A-1. (continued).

Organic COPCs	Organic COPCs (continued)	Organic COPCs (continued)	Inorganic COPCs	Radionuclide COPCs
2,4-dichlorophenol	Bromodichloromethane	Phenol		Ru-106
2,4-dimethylphenol	Bromoform	Potassium		Sb-125
2,4-dinitrophenol	Bromomethane	Pyrene		Sr-90
2,4-dinitrotoluene	Butylbenzylphthalate	Pyridine		U-233/234
2,4,5-trichlorophenol	Carbon disulfide	Silica		U-235
2,4,6-trichlorophenol	Carbon tetrachloride	Sodium		U-238
2,6-dinitrotoluene	Carbazole	Styrene		Zn-65
3-nitroaniline	Chlorobenzene	Sulfide		Zr-95
3,3-dichlorobenzidine	Chloroethane	Tetrachloroethylene		
4-bromophenyl-phenylether	Chloroform	Toluene		
4-chloro-3-methylphenol	Chloromethane	Tributylphosphate		
4-chloroaniline	Chrysene	Trichloroethylene		
4-chlorophenyl-phenylether		Vinyl chloride		
4-methyl-2-pentanone		Xylene (ortho)		
4-methylphenol		Xylene (meta and para)		
4-nitroaniline				
4-nitrophenol				
4,6-dinitro-2-methylphenol				

a. Data taken from DOE/ID-11065 (DOE-ID 2003b).

Table A-2. INEEL background and risk-based concentrations for 1E-06 risk, or HQ = 0.1 for nonradionuclides for both the current occupational and future resident.

Column number	1	2	3	4	5	6
Nonradionuclide COPCs	CAS Number	Cancer or Noncancer	INEEL Background Concentration (mg/kg)[a]	EPA Region 9 Occupational PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	EPA Region 9 Residential PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	Lowest PRG of Columns 4 and 5
1,1-dichloroethane	75-34-3	nc	NA	1.7E+02	5.1E+01	5.1E+01
1,1-dichloroethene	75-35-4	nc	NA	4.1E+01	1.2E+01	1.2E+01
1,1,1-trichloroethane	71-55-6	nc	NA	1.2E+02	1.2E+02	1.2E+02
1,1,2-trichloroethane	79-00-5	ca*	NA	1.6E+00	7.3E-01	7.3E-01
1,1,2,2-tetrachloroethane	79-34-5	ca	NA	9.3E-01	4.1E-01	4.1E-01
1,2-dichlorobenzene	95-50-1	nc	NA	3.7E+01	3.7E+01	3.7E+01
1,2-dichloroethane	107-06-2	ca*	NA	6.0E-01	2.8E-01	2.8E-01
1,2-dichloroethylene	156-59-2	nc	NA	1.5E+01	4.3E+00	4.3E+00
1,2-dichloropropane	78-87-5	ca*	NA	7.4E-01	3.4E-01	3.4E-01
1,2,4-trichlorobenzene	120-82-1	nc	NA	3.0E+02	6.5E+01	6.5E+01
1,3-dichlorobenzene	541-73-1	nc	NA	6.3E+00	1.6E+00	1.6E+00
1,3-dichloropropene[c]	542-75-6	ca	NA	1.8E+00	7.8E-01	7.8E-01
1,4-dichlorobenzene	106-46-7	ca	NA	7.9E+00	3.4E+00	3.4E+00
1,4-dioxane	123-91-1	ca	NA	1.6E+02	4.4E+01	4.4E+01
2-butanone	78-93-3	nc	NA	2.7E+03	7.3E+02	7.3E+02
2-chloronaphthalene	91-58-7	nc	NA	2.3E+03	4.9E+02	4.9E+02
2-chlorophenol	95-57-8	nc	NA	2.4E+01	6.3E+00	6.3E+00
2-hexanone	591-78-6	—	NA	NA	NA	NA

Table A-2. (continued).

Column number	1	2	3	4	5	6
Nonradionuclide COPCs	CAS Number	Cancer or Noncancer	INEEL Background Concentration (mg/kg)[a]	EPA Region 9 Occupational PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	EPA Region 9 Residential PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	Lowest PRG of Columns 4 and 5
2-methylnaphthalene[d]	91-57-6	nc	NA	2.0E+03	1.6E+02	1.6E+02
2-methylphenol	95-48-7	nc	NA	3.1E+03	3.1E+02	3.1E+02
2-nitroaniline	88-74-4	nc	NA	1.8E+00	1.7E-01	1.7E-01
2-nitrophenol	88-75-5	—	NA	NA	NA	NA
2,4-dichlorophenol	120-83-2	nc	NA	1.8E+02	1.8E+01	1.8E+01
2,4-dimethylphenol	105-67-9	nc	NA	1.2E+03	1.2E+02	1.2E+02
2,4-dinitrophenol	51-28-5	nc	NA	1.2E+02	1.2E+01	1.2E+01
2,4-dinitrotoluene	121-14-2	nc	NA	1.2E+02	1.2E+01	1.2E+01
2,4,5-trichlorophenol	95-95-4	nc	NA	6.2E+03	6.1E+02	6.1E+02
2,4,6-trichlorophenol	88-06-2	ca	NA	2.5E+01	6.9E+00	6.9E+00
2,6-dinitrotoluene	606-20-2	nc	NA	6.2E+01	6.1E+00	6.1E+00
3-nitroaniline[d]	99-09-2	nc	NA	1.4E+02	2.3E+00	2.3E+00
3,3-dichlorobenzidine	91-94-1	ca	NA	3.8E+00	1.1E+00	1.1E+00
4-bromophenyl-phenylether	101-55-3	—	NA	NA	NA	NA
4-chloro-3-methylphenol	59-50-7	—	NA	NA	NA	NA
4-chloroaniline	106-47-8	nc	NA	2.5E+02	2.4E+01	2.4E+01
4-chlorophenyl-phenylether	7005-72-3	—	NA	NA	NA	NA
4-methyl-2-pentanone	108-10-1	nc	NA	2.8E+02	7.9E+01	7.9E+01
4-methylphenol	106-44-5	nc	NA	3.1E+02	3.1E+01	3.1E+01
4-nitroaniline[d]	100-01-6	ca	NA	1.4E+02	3.2E+01	3.2E+01

Table A-2. (continued).

Column number	1	2	3	4	5	6
Nonradionuclide COPCs	CAS Number	Cancer or Noncancer	INEEL Background Concentration (mg/kg)[a]	EPA Region 9 Occupational PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	EPA Region 9 Residential PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	Lowest PRG of Columns 4 and 5
4-nitrophenol[d]	100-02-7	nc	NA	8.2E+02	6.3E+01	6.3E+01
4,6-dinitro-2-methylphenol[d]	534-52-1	nc	NA	1.0E+01	7.8E-01	7.8E-01
Acenaphthene	83-32-9	nc	NA	2.9E+03	3.7E+02	3.7E+02
Acenapthylene	208-96-8	—	NA	NA	NA	NA
Acetone	67-64-1	nc	NA	6.0E+02	1.6E+02	1.6E+02
Aluminum[e]	7429-90-5	nc	1.60E+04	1.0E+04	7.6E+03	7.6E+03
Anthracene	120-12-7	nc	NA	1.0E+04	2.2E+03	2.2E+03
Antimony	7440-36-0	nc	4.80E+00	4.1E+01	3.1E+00	3.1E+00
Aroclor-1016	12674-11-2	See notes	NA	2.1E+01(ca**)	3.9E+00 (nc)	3.9E+00
Aroclor-1221	11104-28-2	ca	NA	7.4E-01	2.2E-01	2.2E-01
Aroclor-1232	11141-16-5	ca	NA	7.4E-01	2.2E-01	2.2E-01
Aroclor-1242	53469-21-9	ca	NA	7.4E-01	2.2E-01	2.2E-01
Aroclor-1248	12672-29-6	ca	NA	7.4E-01	2.2E-01	2.2E-01
Aroclor-1254	11097-69-1	ca**	NA	7.4E-01	2.2E-01	2.2E-01
Aroclor-1260	11096-82-5	ca	NA	7.4E-01	2.2E-01	2.2E-01
Arsenic	7440-38-2	ca*	5.80E+00	1.6E+00	3.9E-01	3.9E-01
Barium	7440-39-3	nc	3.00E+02	6.7E+03	5.4E+02	5.4E+02
Benzene	71-43-2	ca*	NA	1.3E+00	6.0E-01	6.0E-01
Benzo(a)anthracene	56-55-3	ca	NA	2.1E+00	6.2E-01	6.2E-01
Benzo(a)pyrene	50-32-8	ca	NA	2.1E-01	6.2E-02	6.2E-02

Table A-2. (continued).

Column number	1	2	3	4	5	6
Nonradionuclide COPCs	CAS Number	Cancer or Noncancer	INEEL Background Concentration (mg/kg)[a]	EPA Region 9 Occupational PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	EPA Region 9 Residential PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	Lowest PRG of Columns 4 and 5
Benzo(b)fluoranthene	205-99-2	ca	NA	2.1E+00	6.2E-01	6.2E-01
Benzo(g,h,i)perylene	191-24-2	—	NA	NA	NA	NA
Benzo(k)fluoranthene	207-08-9	ca	NA	2.1E+01	6.2E+00	6.2E+00
Benzoic acid	65-85-0	max	NA	1.0E+05	1.0E+05	1.0E+05
Benzyl alcohol	100-51-6	nc	NA	1.0E+04	1.8E+03	1.8E+03
Beryllium	7440-41-7	ca**	1.80E+00	1.9E+03	1.5E+02	1.5E+02
Bis(2-chloroethoxy)methane	111-91-1	—	NA	NA	NA	NA
Bis(2-chloroethyl)ether	111-44-4	ca	NA	5.5E-01	2.1E-01	2.1E-01
Bis(2-chloroisopropyl)ether	39638-32-9	ca	NA	7.4E+00	2.9E+00	2.9E+00
Bis(2-ethylhexyl)phthalate	117-81-7	ca*	NA	1.2E+02	3.5E+01	3.5E+01
Boron	7440-42-8	nc	1.73E+01	1.0E+04	1.6E+03	1.6E+03
Bromodichloromethane	75-27-4	ca	NA	1.8E+00	8.2E-01	8.2E-01
Bromoform	75-25-2	ca*	NA	2.2E+02	6.2E+01	6.2E+01
Bromomethane	74-83-9	nc	NA	1.3E+00	3.9E-01	3.9E-01
Butylbenzylphthalate	85-68-7	nc	NA	1.0E+04	1.2E+03	1.2E+03
Cadmium	7440-43-9	nc	2.20E+00	7.4E+00	1.7E+00	1.7E+00
Carbon disulfide	75-15-0	nc	NA	7.2E+01	3.6E+01	3.6E+01
Carbon tetrachloride	56-23-5	ca**	NA	5.5E-01	2.5E-01	2.5E-01
Carbazole	86-74-8	ca	NA	8.6E+02	2.4E+01	2.4E+01
Chlorobenzene	108-90-7	nc	NA	5.3E+01	1.5E+01	1.5E+01

Table A-2. (continued).

Column number	1	2	3	4	5	6
Nonradionuclide COPCs	CAS Number	Cancer or Noncancer	INEEL Background Concentration (mg/kg)[a]	EPA Region 9 Occupational PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	EPA Region 9 Residential PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	Lowest PRG of Columns 4 and 5
Chloroethane	75-00-3	ca	NA	6.5E+00	3.0E+00	3.0E+00
Chloroform	67-66-3	ca/nc	NA	1.2E+00	3.6E-01	3.6E-01
Chloromethane	74-87-3	ca	NA	2.6E+00	1.2E+00	1.2E+00
Chromium (Total)	—	ca	3.30E+01	4.5E+02	2.1E+02	2.1E+02
Chrysene	218-01-9	ca	NA	2.1E+02	6.2E+01	6.2E+01
Cobalt	7440-48-4	ca**	1.10E+01	1.9E+03	9.0E+02	9.0E+02
Copper	7440-50-8	nc	2.20E+01	4.1E+03	3.1E+02	3.1E+02
Dibenz(a,h)anthracene	53-70-3	ca	NA	2.1E-01	6.2E-02	6.2E-02
Dibenzofuran	132-64-9	nc	NA	3.1E+02	2.9E+01	2.9E+01
Dibromochloromethane	124-48-1	ca	NA	2.6E+00	1.1E+00	1.1E+00
Dibutylphthalate	84-74-2	nc	NA	6.2E+03	6.1E+02	6.1E+02
Diethylphthalate	84-66-2	nc	NA	1.0E+04	4.9E+03	4.9E+03
Dimethylphthalate	131-11-3	max	NA	1.0E+05	1.0E+05	1.0E+05
Di-n-octylphthalate	117-84-0	nc	NA	2.5E+03	2.4E+02	2.4E+02
Ethylbenzene	100-41-4	ca	NA	2.0E+01	8.9E+00	8.9E+00
Fluoranthene	206-44-0	nc	NA	2.2E+03	2.3E+02	2.3E+02
Fluorene	86-73-7	nc	NA	2.6E+03	2.7E+02	2.7E+02
Hexachlorobenzene	118-74-1	ca	NA	1.1E+00	3.0E-01	3.0E-01
Hexachlorobutadiene	87-68-3	ca**	NA	2.2E+01	6.2E+00	6.2E+00
Hexachlorocyclopentadiene	77-47-4	nc	NA	3.7E+02	3.7E+01	3.7E+01

Table A-2. (continued).

Column number	1	2	3	4	5	6
Nonradionuclide COPCs	CAS Number	Cancer or Noncancer	INEEL Background Concentration (mg/kg)[a]	EPA Region 9 Occupational PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	EPA Region 9 Residential PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	Lowest PRG of Columns 4 and 5
Hexachloroethane	67-72-1	ca**	NA	1.2E+02	3.5E+01	3.5E+01
Indeno(1,2,3-cd)pyrene	193-39-5	ca	NA	2.1E+00	6.2E-01	6.2E-01
Iron[e]	7439-89-6	nc	2.40E+04	1.0E+04	2.3E+03	2.3E+03
Isophorone	78-59-1	ca*	NA	1.8E+03	5.1E+02	5.1E+02
Lead	7439-92-1	nc	1.70E+01	7.5E+01	4.0E+01	4.0E+01
Magnesium[e]	7439-95-4	—	1.20E+04	NA	NA	NA
Manganese	7439-96-5	nc	4.90E+02	1.9E+03	1.8E+02	1.8E+02
Mercury	7487-94-7	nc	5.00E-02	3.1E+01	2.3E+00	2.3E+00
Methylene chloride	75-09-2	ca	NA	2.1E+01	9.1E+00	9.1E+00
N-nitroso-di-n-propylamine	621-64-7	ca	NA	2.5E-01	6.9E-02	6.9E-02
N-nitrosodiphenylamine	86-30-6	ca	NA	3.5E+02	9.9E+01	9.9E+01
Naphthalene	91-20-3	nc	NA	1.9E+01	5.6E+00	5.6E+00
Nickel	7440-02-0	nc	3.50E+01	2.0E+03	1.6E+02	1.6E+02
Nitrobenzene	98-95-3	nc	NA	1.0E+01	2.0E+00	2.0E+00
Pentachlorophenol	87-86-5	ca	NA	9.0E+00	3.0E+00	3.0E+00
Phenanthrene	85-01-8	—	NA	NA	NA	NA
Phenol	108-95-2	nc	NA	1.0E+04	3.7E+03	3.7E+03
Potassium[e]	7440-09-7	—	4.30E+03	NA	NA	NA
Pyrene	129-00-0	nc	NA	2.9E+03	2.3E+02	2.3E+02
Pyridine	110-86-1	nc	NA	6.2E+01	6.1E+00	6.1E+00
Selenium	7782-49-2	nc	2.20E-01	5.1E+02	3.9E+01	3.9E+01

Table A-2. (continued).

Column number	1	2	3	4	5	6
Nonradionuclide COPCs	CAS Number	Cancer or Noncancer	INEEL Background Concentration (mg/kg)[a]	EPA Region 9 Occupational PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	EPA Region 9 Residential PRGs (mg/kg) (1E-06 or HQ of 0.1)[b]	Lowest PRG of Columns 4 and 5
Silica	7631-86-9	—	NA	NA	NA	NA
Silver	7440-22-4	nc	NA	5.1E+02	3.9E+01	3.9E+01
Sodium[e]	7440-23-5	—	3.20E+02	NA	NA	NA
Styrene	88671-89-0	nc	NA	1.7E+02	1.7E+02	1.7E+02
Sulfide	—	—	NA	NA	NA	NA
Tetrachloroethylene	127-18-4	ca*	NA	3.4E+00	1.5E+00	1.5E+00
Thallium	7440-28-0	nc	4.30E-01	6.7E+00	5.2E-01	5.2E-01
Tin	7440-31-5	nc	NA	1.0E+04	4.7E+03	4.7E+03
Toluene	108-88-3	sat	NA	5.2E+02	5.2E+02	5.2E+02
Tributylphosphate	126-73-8	—	NA	NA	NA	NA
Trichloroethylene	79-01-6	ca	NA	1.1E-01	5.3E-02	5.3E-02
Vanadium	7440-62-2	nc	4.50E+01	7.2E+02	5.5E+01	5.5E+01
Vinyl chloride	75-01-4	ca	NA	7.5E-01	7.9E-02	7.9E-02
Xylene[f]	1330-20-7	nc	NA	4.2E+01	2.7E+01	2.7E+01
Zinc	7440-66-6	nc	1.50E+02	1.0E+04	2.3E+03	2.3E+03

ca = carcinogenic PRG
ca* = where nc < 100 × ca
ca** = where nc < 10 × ca
nc = noncarcinogenic PRG
nc** = where ca < 10 × nc
max = ceiling limit

Table A-3. INEEL background and risk-based concentrations (at 1E-06 risk) for radionuclides for both the current occupational and future resident.

Column #	1	2	3	4	5	6	7
Radionuclide COPCs	CAS Numbers	Half Life (years)	INEEL Background Concentration (pCi/g)[a]	Current Occupational (External only) (pCi/g)[b]	Current Occupational (Soil Ingestion) (pCi/g)[b]	Future Resident (Lowest of External and Soil Ingestion Values) (pCi/g)[b]	Lowest RBC of Columns 4, 5 and 6 (pCi/g)
Ag-108m	14391-65-2	1.27E+02	NA	3.5E-02	5.7E+02	1.2E-02	1.2E-02
Ag-110m	14391-76-5	6.85E-01	NA	1.2E+00	2.6E+04	8.9E+42	1.2E+00
Am-241	14596-10-2	4.32E+02	1.10E-02	4.0E+01	1.0E+01	2.9E+00	2.9E+00
Ce-144	14762-78-8	7.78E-01	NA	6.3E+01	5.8E+03	2.9E+39	2.2E+02
Cm-242	15510-73-3	4.47E-01	NA	1.4E+06	1.5E+04	2.4E+70	1.5E+04
Cm-243/244	13981-15-2	1.81E+01	NA	1.4E+04	2.4E+01	2.9E+02	2.4E+01
Co-58	13981-38-9	1.94E-01	NA	NA	NA	NA	NA
Co-60	10198-40-0	5.27E+00	NA	7.2E-02	6.6E+02	7.4E+03	7.2E-02
Cs-134	13967-70-9	2.06E+00	NA	3.6E-01	8.0E+02	2.4E+13	3.6E-01
Eu-152	14683-23-9	1.36E+01	NA	8.2E-02	1.0E+03	2.7E+00	8.2E-02
Eu-154	15585-10-1	8.80E+00	NA	9.6E-02	8.5E+02	5.2E+01	9.6E-02
Eu-155	14391-16-3	4.96E+00	NA	1.2E+01	8.0E+03	2.9E+06	1.2E+01
H-3	10028-17-8	1.23E+01	NA	NA	8.8E+04	6.5E+06	8.8E+04
I-129	15046-84-1	1.57E+07	NA	6.7E+01	1.7E+01	1.3E+01	1.3E+01
K-40	13966-00-2	1.28E+09	NA	2.9E-01	2.6E+02	5.7E-02	5.7E-02
Mn-54	13966-31-9	8.58E-01	NA	2.5E+00	7.4E+04	3.3E+34	2.5E+00
Nb-94	14681-63-1	2.03E+04	NA	3.0E-02	4.6E+02	5.8E-03	5.8E-03
Nb-95	13967-76-5	9.64E-02	NA	1.1E+01[c]	NA	6.8E+00[c]	6.8E+00[c]

Table A-3. (continued).

Column #	1	2	3	4	5	6	7
Radionuclide COPCs	CAS Numbers	Half Life (years)	INEEL Background Concentration (pCi/g)[a]	Current Occupational (External only) (pCi/g) [b]	Current Occupational (Soil Ingestion) (pCi/g)[b]	Future Resident (Lowest of External and Soil Ingestion Values) (pCi/g) [b]	Lowest RBC of Columns 4, 5 and 6 (pCi/g)
Ni-63	13981-37-8	1.00E+02	NA	NA	6.4E+03	3.2E+03	3.2E+03
Np-237	13994-20-2	2.14E+06	NA	3.9E-01	1.1E+01	7.6E-02	3.9E-01
Pu-238	13981-16-3	8.78E+01	4.90E-03	1.0E+04	1.2E+01	6.7E+00	6.7E+00
Pu-239/240	14119-33-6	2.41E+04	1.00E-01	9.6E+03	1.0E+01	2.5E+00	2.5E+00
Ra-226	13982-63-3	1.60E+03	NA	2.7E-02	1.1E+01	5.5E-03	5.5E-03
Ru-103	13968-53-1	1.08E-01	NA	NA	NA	NA	NA
Ru-106	13967-48-1	1.01E+00	NA	8.1E+00	3.2E+03	6.9E+29	8.1E+00
Sb-125	14234-35-6	2.77E+00	NA	1.1E+00	7.3E+03	1.4E+10	1.1E+00
Sr-90	10098-97-2	2.86E+01	4.90E-01	NA	7.8E+01	2.3E+02	7.8E+01
U-233/234	13966-29-5	2.45E+05	1.44E+00	8.4E+03	7.2E+01	1.8E+01	1.8E+01
U-235	15117-96-1	7.04E+08	NA	6.8E-01	6.8E+01	1.3E-01	1.3E-01
U-238	7440-61-1	4.47E+09	1.40E+00	3.4E+00	5.2E+01	6.7E-01	6.7E-01
Zn-65	13982-39-3	6.68E-01	NA	5.8E+00	2.4E+04	5.0E+44	5.8E+00
Zr-95	13967-71-0	1.75E-01	NA	NA	NA	1.5E+03	1.5E+03

a. (Rood et al. 1996)
b. Values from Jeff Fromm Memorandum (Fromm 1996) for RBCs for radionuclides decayed through the exposure period.
c. Values from http://epa-prgs.oml.gov/radionuclides/prg.search.shtml (May 2004).

Table A-4. Risk-based concentrations (1E-05 or HQ = 0.1) for nonradionuclides for both the current occupational and future resident.

Column #	1	2	3	4	5
Nonradionuclide COPCs	CAS Number	Cancer or NonCancer	EPA Region 9 Occupational PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	EPA Region 9 Residential PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	Lower PRG from Column 3 and 4
1,1-dichloroethane	75-34-3	nc	1.7E+02	5.1E+01	5.1E+01
1,1-dichloroethene	75-35-4	nc	4.1E+01	1.2E+01	1.2E+01
1,1,1-trichloroethane	71-55-6	nc	1.2E+03	1.2E+03	1.2E+03
1,1,2-trichloroethane	79-00-5	ca*	1.6E+01	7.3E+00	7.3E+00
1,1,2,2-tetrachloroethane	79-34-5	ca	9.3E+00	4.1E+00	4.1E+00
1,2-dichlorobenzene	95-50-1	nc	3.7E+02	3.7E+02	3.7E+02
1,2-dichloroethane	107-06-2	ca*	6.0E+00	2.8E+00	2.8E+00
1,2-dichloroethylene	156-59-2	nc	1.5E+01	4.3E+00	4.3E+00
1,2-dichloropropane	78-87-5	ca*	7.4E+00	3.4E+00	3.4E+00
1,2,4-trichlorobenzene	120-82-1	nc	3.0E+02	6.5E+01	6.5E+01
1,3-dichlorobenzene	541-73-1	nc	6.3E+00	1.6E+00	1.6E+00
1,3-dichloropropene[b]	542-75-6	ca	1.8E+01	7.8E+00	7.8E+00
1,4-dichlorobenzene	106-46-7	ca	7.9E+01	3.4E+01	3.4E+01
1,4-dioxane	123-91-1	ca	1.6E+03	4.4E+02	4.4E+02
2-butanone	78-93-3	nc	2.7E+03	7.3E+02	7.3E+02
2-chloronaphthalene	91-58-7	nc	2.3E+03	4.9E+02	4.9E+02
2-chlorophenol	95-57-8	nc	2.4E+01	6.3E+00	6.3E+00
2-hexanone	591-78-6	—	NA	NA	NA
2-methylnaphthalene[c]	91-57-6	nc	2.0E+03	1.6E+02	1.6E+02
2-methylphenol	95-48-7	nc	3.1E+03	3.1E+02	3.1E+02
2-nitroaniline	88-74-4	nc	1.8E+00	1.7E-01	1.7E-01

Table A-4. (continued).

Column #	1	2	3	4	5
Nonradionuclide COPCs	CAS Number	Cancer or NonCancer	EPA Region 9 Occupational PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	EPA Region 9 Residential PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	Lower PRG from Column 3 and 4
2-nitrophenol	88-75-5	—	NA	NA	NA
2,4-dichlorophenol	120-83-2	nc	1.8E+02	1.8E+01	1.8E+01
2,4-dimethylphenol	105-67-9	nc	1.2E+03	1.2E+02	1.2E+02
2,4-dinitrophenol	51-28-5	nc	1.2E+02	1.2E+01	1.2E+01
2,4-dinitrotoluene	121-14-2	nc	1.2E+02	1.2E+01	1.2E+01
2,4,5-trichlorophenol	95-95-4	nc	6.2E+03	6.1E+02	6.1E+02
2,4,6-trichlorophenol	88-06-2	ca	2.5E+02	6.9E+01	6.9E+01
2,6-dinitrotoluene	606-20-2	nc	6.2E+01	6.1E+00	6.1E+00
3-nitroaniline[c]	99-09-2	nc	1.4E+02	2.3E+00	2.3E+00
3,3-dichlorobenzidine	91-94-1	ca	3.8E+01	1.1E+01	1.1E+01
4-bromophenyl-phenylether	101-55-3	—	NA	NA	NA
4-chloro-3-methylphenol	59-50-7	—	NA	NA	NA
4-chloroaniline	106-47-8	nc	2.5E+02	2.4E+01	2.4E+01
4-chlorophenyl-phenylether	7005-72-3	—	NA	NA	NA
4-methyl-2-pentanone	108-10-1	nc	2.8E+02	7.9E+01	7.9E+01
4-methylphenol	106-44-5	nc	3.1E+02	3.1E+01	3.1E+01
4-nitroaniline[c]	100-01-6	ca	1.4E+03	3.2E+02	3.2E+02
4-nitrophenol[c]	100-02-7	nc	8.2E+02	6.3E+01	6.3E+01
4,6-dinitro-2-methylphenol[c]	534-52-1	nc	1.0E+01	7.8E-01	7.8E-01
Acenaphthene	83-32-9	nc	2.9E+03	3.7E+02	3.7E+02
Acenapthylene	208-96-8	—	NA	NA	NA

Table A-4. (continued).

Column #	1	2	3	4	5
Nonradionuclide COPCs	CAS Number	Cancer or NonCancer	EPA Region 9 Occupational PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	EPA Region 9 Residential PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	Lower PRG from Column 3 and 4
Acetone	67-64-1	nc	6.0E+02	1.6E+02	1.6E+02
Aluminum[d]	7429-90-5	nc	1.0E+04	7.6E+03	7.6E+03
Anthracene	120-12-7	nc	1.0E+04	2.2E+03	2.2E+03
Antimony	7440-36-0	nc	4.1E+01	3.1E+00	3.1E+00
Aroclor-1016	12674-11-2	nc	2.1E+02	3.9E+00	3.9E+00
Aroclor-1221	11104-28-2	ca	7.4E+00	2.2E+00	2.2E+00
Aroclor-1232	11141-16-5	ca	7.4E+00	2.2E+00	2.2E+00
Aroclor-1242	53469-21-9	ca	7.4E+00	2.2E+00	2.2E+00
Aroclor-1248	12672-29-6	ca	7.4E+00	2.2E+00	2.2E+00
Aroclor-1254	11097-69-1	ca**	7.4E+00	2.2E+00	2.2E+00
Aroclor-1260	11096-82-5	ca	7.4E+00	2.2E+00	2.2E+00
Arsenic	7440-38-2	ca*	1.6E+01	3.9E+00	3.9E+00
Barium	7440-39-3	nc	6.7E+03	5.4E+02	5.4E+02
Benzene	71-43-2	ca*	1.3E+01	6.0E+00	6.0E+00
Benzo(a)anthracene	56-55-3	ca	2.1E+01	6.2E+00	6.2E+00
Benzo(a)pyrene	50-32-8	ca	2.1E+00	6.2E-01	6.2E-01
Benzo(b)fluoranthene	205-99-2	ca	2.1E+01	6.2E+00	6.2E+00
Benzo(g,h,i)perylene	191-24-2	—	NA	NA	NA
Benzo(k)fluoranthene	207-08-9	ca	2.1E+02	6.2E+01	6.2E+01
Benzoic acid	65-85-0	max	1.0E+05	1.0E+05	1.0E+05
Benzyl alcohol	100-51-6	nc	1.0E+04	1.8E+03	1.8E+03

Table A-4. (continued).

Column #	1	2	3	4	5
Nonradionuclide COPCs	CAS Number	Cancer or NonCancer	EPA Region 9 Occupational PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	EPA Region 9 Residential PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	Lower PRG from Column 3 and 4
Beryllium	7440-41-7	nc	1.9E+04	1.5E+02	1.5E+02
Bis(2-chloroethoxy)methane	111-91-1	—	NA	NA	NA
Bis(2-chloroethyl)ether	111-44-4	ca	5.5E+00	2.1E+00	2.1E+00
Bis(2-chloroisopropyl)ether	39638-32-9	ca	7.4E+01	2.9E+01	2.9E+01
Bis(2-ethylhexyl)phthalate	117-81-7	ca*	1.2E+03	3.5E+02	3.5E+02
Boron	7440-42-8	nc	1.0E+04	1.6E+03	1.6E+03
Bromodichloromethane	75-27-4	ca	1.8E+01	8.2E+00	8.2E+00
Bromoform	75-25-2	ca*	2.2E+03	6.2E+02	6.2E+02
Bromomethane	74-83-9	nc	1.3E+00	3.9E-01	3.9E-01
Butylbenzylphthalate	85-68-7	nc	1.0E+04	1.2E+03	1.2E+03
Cadmium	7440-43-9	ca	7.4E+01	1.7E+01	1.7E+01
Carbon disulfide	75-15-0	nc	7.2E+01	3.6E+01	3.6E+01
Carbon tetrachloride	56-23-5	ca**	5.5E+00	2.5E+00	2.5E+00
Carbazole	86-74-8	ca	8.6E+02	2.4E+02	2.4E+02
Chlorobenzene	108-90-7	nc	5.3E+01	1.5E+01	1.5E+01
Chloroethane	75-00-3	ca	6.5E+01	3.0E+01	3.0E+01
Chloroform	67-66-3	ca/nc	1.2E+00	3.6E-01	3.6E-01
Chloromethane	74-87-3	ca	2.6E+01	1.2E+01	1.2E+01
Chromium (Total)	—	ca	4.5E+03	2.1E+03	2.1E+03
Chrysene	218-01-9	ca	2.1E+03	6.2E+02	6.2E+02
Cobalt	7440-48-4	ca**	1.9E+04	9.0E+03	9.0E+03

Table A-4. (continued).

Column #	1	2	3	4	5
Nonradionuclide COPCs	CAS Number	Cancer or NonCancer	EPA Region 9 Occupational PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	EPA Region 9 Residential PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	Lower PRG from Column 3 and 4
Copper	7440-50-8	nc	4.1E+03	3.1E+02	3.1E+02
Dibenz(a,h)anthracene	53-70-3	ca	2.1E+00	6.2E-01	6.2E-01
Dibenzofuran	132-64-9	nc	3.1E+02	2.9E+01	2.9E+01
Dibromochloromethane	124-48-1	ca	2.6E+01	1.1E+01	1.1E+01
Dibutylphthalate	84-74-2	nc	6.2E+03	6.1E+02	6.1E+02
Diethylphthalate	84-66-2	nc	1.0E+04	4.9E+03	4.9E+03
Dimethylphthalate	131-11-3	max	1.0E+05	1.0E+05	1.0E+05
Di-n-octylphthalate	117-84-0	nc	2.5E+03	2.4E+02	2.4E+02
Ethylbenzene	100-41-4	ca	2.0E+02	8.9E+01	8.9E+01
Fluoranthene	206-44-0	nc	2.2E+03	2.3E+02	2.3E+02
Fluorene	86-73-7	nc	2.6E+03	2.7E+02	2.7E+02
Hexachlorobenzene	118-74-1	ca	1.1E+01	3.0E+00	3.0E+00
Hexachlorobutadiene	87-68-3	ca**	2.2E+02	6.2E+01	6.2E+01
Hexachlorocyclopentadiene	77-47-4	nc	3.7E+02	3.7E+01	3.7E+01
Hexachloroethane	67-72-1	ca**	1.2E+03	3.5E+02	3.5E+02
Indeno(1,2,3-cd)pyrene	193-39-5	ca	2.1E+01	6.2E+00	6.2E+00
Iron[d]	7439-89-6	nc	1.0E+04	2.3E+03	2.3E+03
Isophorone	78-59-1	ca*	1.8E+04	5.1E+03	5.1E+03
Lead	7439-92-1	nc	7.5E+01	4.0E+01	4.0E+01
Magnesium[d]	7439-95-4	—	NA	NA	NA
Manganese	7439-96-5	nc	1.9E+03	1.8E+02	1.8E+02
Mercury	7487-94-7	nc	3.1E+01	2.3E+00	2.3E+00

Table A-4. (continued).

Column #	1	2	3	4	5
Nonradionuclide COPCs	CAS Number	Cancer or NonCancer	EPA Region 9 Occupational PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	EPA Region 9 Residential PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	Lower PRG from Column 3 and 4
Methylene chloride	75-09-2	ca	2.1E+02	9.1E+01	9.1E+01
N-nitroso-di-n-propylamine	621-64-7	ca	2.5E+00	6.9E-01	6.9E-01
N-nitrosodiphenylamine	86-30-6	ca	3.5E+03	9.9E+02	9.9E+02
Naphthalene	91-20-3	nc	1.9E+01	5.6E+00	5.6E+00
Nickel	7440-02-0	nc	2.0E+03	1.6E+02	1.6E+02
Nitrobenzene	98-95-3	nc	1.0E+01	2.0E+00	2.0E+00
Pentachlorophenol	87-86-5	ca	9.0E+01	3.0E+01	3.0E+01
Phenanthrene	85-01-8	—	NA	NA	NA
Phenol	108-95-2	nc	1.0E+04	3.7E+03	3.7E+03
Potassium[d]	7440-09-7	—	NA	NA	NA
Pyrene	129-00-0	nc	2.9E+03	2.3E+02	2.3E+02
Pyridine	110-86-1	nc	6.2E+01	6.1E+00	6.1E+00
Selenium	7782-49-2	nc	5.1E+02	3.9E+01	3.9E+01
Silica	7631-86-9	—	NA	NA	NA
Silver	7440-22-4	nc	5.1E+02	3.9E+01	3.9E+01
Sodium[d]	7440-23-5	—	NA	NA	NA
Styrene	88671-89-0	nc	1.7E+02	1.7E+02	1.7E+02
Sulfide	—	—	NA	NA	NA
Tetrachloroethylene	127-18-4	ca*	3.4E+01	1.5E+01	1.5E+01
Thallium	7440-28-0	nc	6.7E+00	5.2E-01	5.2E-01
Tin	7440-31-5	nc	1.0E+04	4.7E+03	4.7E+03

Table A-4. (continued).

Column #	1	2	3	4	5
Nonradionuclide COPCs	CAS Number	Cancer or NonCancer	EPA Region 9 Occupational PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	EPA Region 9 Residential PRGs (mg/kg) (1E-05 or HQ of 0.1)[a]	Lower PRG from Column 3 and 4
Toluene	106-88-3	sat	5.2E+02	5.2E+02	5.2E+02
Tributylphosphate	126-73-8	—	NA	NA	NA
Trichloroethylene	79-01-6	ca	1.1E+00	5.3E-01	5.3E-01
Vanadium	7440-62-2	nc	7.2E+02	5.5E+01	5.5E+01
Vinyl chloride	75-01-4	ca	7.5E+00	7.9E-01	7.9E-01
Xylene[e]	1330-20-7	na	4.2E+01	2.7E+01	2.7E+01
Zinc	7440-66-6	nc	1.0E+04	2.3E+03	2.3E+03

ca = carcinogenic PRG
ca* = where nc < 100 × ca
ca** = where nc < 10 × ca
nc = noncarcinogenic PRG
nc** = where ca < 10 × nc
sat = soil saturation limit
max = ceiling limit
a. (EPA 2003a)
b. The PRGs for 1,3-dichloropropene represents a mixture both the cis and tran version of this chemical.
c. The PRG for this contaminant was taken from EPA Region 3 (EPA 2003a).
d. This contaminant is an essential nutrient and can be screened unless the detected concentration is greater than 10 times the INEEL background concentration.
e. The PRGs for Xylene represent a totals mix of ortho, meta, and para versions of this chemical.

Table A-5. Risk-based concentrations (1E-05) for radionuclides for both the current occupational and future resident.

Column Number	1	2	3	4	5	
Radionuclide COPCs	CAS Numbers	Half Life (years)	Current Occupational (External only) (pCi/g) [a]	Current Occupational (Aoil Ingestion) (pCi/g)[a]	Future Resident (Lowest of External and Soil Ingestion Values) (pCi/g) [a]	Lowest RBC of Columns 4, 5 and 6 (pCi/g)
Ag-108m	14391-65-2	1.27E+02	3.50E-01	5.7E+03	1.20E-01	1.20E-01
Ag-110m	14391-76-5	6.85E-01	1.20E+01	2.6E+05	8.90E+43	1.20E+01
Am-241	14596-10-2	4.32E+02	4.00E+02	1.0E+02	2.90E+01	2.90E+01
Ce-144	14762-78-8	7.78E-01	6.30E+02	5.8E+04	2.90E+40	6.30E+02
Cm-242	15510-73-3	4.47E-01	1.40E+07	1.5E+05	2.40E+71	1.50E+05
Cm-243/244	13981-15-2	1.81E+01	1.40E+05	2.4E+02	2.90E+03	2.40E+02
Co-58	13981-38-9	1.94E-01	NA	NA	NA	NA
Co-60	10198-40-0	5.27E+00	7.20E-01	6.6E+03	7.40E+04	7.20E-01
Cs-134	13967-70-9	2.06E+00	3.60E+00	8.0E+03	2.40E+14	3.60E+00
Eu-152	14683-23-9	1.36E+01	8.20E-01	1.0E+04	2.70E+01	8.20E-01
Eu-154	15585-10-1	8.80E+00	9.60E-01	8.5E+03	5.20E+02	9.60E-01
Eu-155	14391-16-3	4.96E+00	1.20E+02	8.0E+04	2.90E+07	1.20E+02
H-3	10028-17-8	1.23E+01	NA	8.8E+05	6.50E+07	8.80E+05
I-129	15046-84-1	1.57E+07	6.70E+02	1.7E+02	1.30E+02	1.30E+02
K-40	13966-00-2	1.28E+09	2.9E+00	2.6E+03	5.7E-01	5.7E-01
Mn-54	13966-31-9	8.58E-01	2.50E+01	7.4E+05	3.30E+35	2.50E+01
Nb-94	14681-63-1	2.03E+04	3.0E-01	4.6E+03	5.8E-02	5.8E-02
Nb-95	13967-7-65	9.64E-02	1.1E+02[b]	NA	6.8E+01 [b]	6.8E+01 [b]
Ni-63	13981-37-8	1.00E+02	NA	6.4E+04	NA	NA
Np-237	13994-20-2	2.14E+06	3.90E+00	1.1E+02	7.60E-01	3.90E+00

Table A-5. (continued).

Column Number	1	2	3	4	5	
Radionuclide COPCs	CAS Numbers	Half Life (years)	Current Occupational (External only) (pCi/g) [a]	Current Occupational (Aoil Ingestion) (pCi/g)[a]	Future Resident (Lowest of External and Soil Ingestion Values) (pCi/g) [a]	Lowest RBC of Columns 4, 5 and 6 (pCi/g)
Pu-238	13981-16-3	8.78E+01	1.00E+05	1.2E+02	6.70E+01	6.70E+01
Pu-239/240	14119-33-6	2.41E+04	9.60E+04	1.0E+02	2.50E+01	2.50E+01
Ra-226	13982-63-3	1.60E+03	2.70E-01	1.1E+02	5.50E-02	5.50E-02
Ru-103	13968-53-1	1.08E-01	NA	NA	NA	NA
Ru-106	13967-48-1	1.01E+00	8.10E+01	3.2E+04	6.90E+30	8.10E+01
Sb-125	14234-35-6	2.77E+00	1.10E+01	7.3E+04	1.40E+11	1.10E+01
Sr-90	10098-97-2	2.86E+01	NA	7.8E+02	2.30E+03	7.80E+02
U-233/234	13966-29-5	2.45E+05	8.40E+04	7.2E+02	1.80E+02	1.80E+02
U-235	15117-96-1	7.04E+08	6.80E+00	6.8E+02	1.30E+00	1.30E+00
U-238	7440-61-1	4.47E+09	3.40E+01	5.2E+02	6.70E+00	6.70E+00
Zn-65	13982-39-3	6.68E-01	5.80E+01	2.4E+05	5.00E+45	5.80E+01
Zr-95	13967-71-0	1.75E-01	NA	NA	1.50E+04	1.50E+04

a. Values were taken from (Fromm 1996).
b. Values from http://epa-prgs.ornl.gov/radionuclides/prg.search.shtml (May 2004).

Table A-6. INEEL background, ecological SSLs, and INEEL EBSLs for nonradionuclides and radionuclides.

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
1,1-dichloroethane	75-34-3	NA	NA	6.95E+00
1,1-dichloroethene	75-35-4	NA	NA	2.19E+00
1,1,1-trichloroethane	71-55-6	NA	NA	8.13E+02
1,1,2-trichloroethane	79-00-5	NA	NA	NA
1,1,2,2-tetrachloroethane	79-34-5	NA	NA	1.67E+01
1,2-dichlorobenzene	95-50-1	NA	NA	NA
1,2-dichloroethane	107-06-2	NA	4.00E-01	1.39E+00
1,2-dichloroethylene	156-59-2	NA	NA	NA
1,2-dichloropropane	78-87-5	NA	700	NA
1,2,4-trichlorobenzene	120-82-1	NA	1.00E-02	1.82E+00
1,3-dichlorobenzene	541-73-1	NA	NA	NA
1,3-dichloropropene[d]	542-75-6	NA	NA	NA
1,4-dichlorobenzene	106-46-7	NA	1.00E-02	NA
1,4-dioxane	123-91-1	NA	NA	1.58E-02
2-butanone	78-93-3	NA	NA	3.83E+01
2-chloronaphthalene	91-58-7	NA	NA	NA
2-chlorophenol	95-57-8	NA	NA	NA
2-hexanone	591-78-6	NA	NA	NA
2-methylnaphthalene	91-57-6	NA	NA	NA
2-methylphenol	95-48-7	NA	NA	NA
2-nitroaniline	88-74-4	NA	NA	NA

Table A-6. (continued).

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
2-nitrophenol	88-75-5	NA	NA	NA
2,4-dichlorophenol	120-83-2	NA	NA	NA
2,4-dimethylphenol	105-67-9	NA	NA	3.75E+01
2,4-dinitrophenol	51-28-5	NA	2.00E+01	NA
2,4-dinitrotoluene	121-14-2	NA	NA	1.54E+00
2,4,5-trichlorophenol	95-95-4	NA	4	NA
2,4,6-trichlorophenol	88-06-2	NA	1.00E+01	NA
2,6-dinitrotoluene	606-20-2	NA	NA	2.18E+00
3-nitroaniline	99-09-2	NA	NA	NA
3,3-dichlorobenzidine	91-94-1	NA	NA	NA
4-bromophenyl-phenylether	101-55-3	NA	NA	NA
4-chloro-3-methylphenol	59-50-7	NA	NA	1.80E+01
4-chloroaniline	106-47-8	NA	NA	5.35E-01
4-chlorophenyl-phenylether	7005-72-3	NA	NA	NA
4-methyl-2-pentanone	108-10-1	NA	NA	NA
4-methylphenol	106-44-5	NA	NA	4.92E+00
4-nitroaniline	100-01-6	NA	NA	NA
4-nitrophenol	100-02-7	NA	7.00E+00	NA
4,6-dinitro-2-methylphenol	534-52-1	NA	NA	NA
Acenaphthene	83-32-9	NA	2.00E+01	4.74E+01
Acenapthylene	208-96-8	NA	NA	NA
Acetone	67-64-1	NA	NA	5.53E-01

Table A-6. (continued).

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
Aluminum	7429-90-5	1.60E+04	5.00E+01	8.50E+00
Anthracene	120-12-7	NA	1.00E-01	1.35E+02
Antimony	7440-36-0	4.80E+00	3.50E+00	1.35E+00
Aroclor-1016	12674-11-2	NA	NA	NA
Aroclor-1221	11104-28-2	NA	NA	NA
Aroclor-1232	11141-16-5	NA	NA	NA
Aroclor-1242	53469-21-9	NA	NA	NA
Aroclor-1248	12672-29-6	NA	NA	NA
Aroclor-1254	11097-69-1	NA	NA	1.66E-01
Aroclor-1260	11096-82-5	NA	NA	8.02E+00
Arsenic	7440-38-2	5.80E+00	1.00E+01	8.44E-01
Barium	7440-39-3	3.00E+02	1.65E+02	1.10E+01
Benzene	71-43-2	NA	5.00E-02	5.50E+00
Benzo(a)anthracene	56-55-3	NA	NA	3.02E+01
Benzo(a)pyrene	50-32-8	NA	1.00E-01	2.69E+00
Benzo(b)fluoranthene	205-99-2	NA	NA	NA
Benzo(g,h,i)perylene	191-24-2	NA	NA	NA
Benzo(k)fluoranthene	207-08-9	NA	NA	NA
Benzoic acid	65-85-0	NA	NA	NA
Benzyl alcohol	100-51-6	NA	NA	NA
Beryllium	7440-41-7	1.80E+00	1.10E+00	7.14E-01
Bis(2-chloroethoxy)methane	111-91-1	NA	NA	NA

Table A-6. (continued).

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
Bis(2-chloroethyl)ether	111-44-4	NA	NA	NA
Bis(2-chloroisopropyl)ether	39638-32-9	NA	NA	NA
Bis(2-ethylhexyl)phthalate	117-81-7	NA	NA	2.56E+00
Boron	7440-42-8	1.73E+01	5.00E-01	5.00E-01
Bromodichloromethane	75-27-4	NA	NA	NA
Bromoform	75-25-2	NA	NA	NA
Bromomethane	74-83-9	NA	NA	NA
Butylbenzylphthalate	85-68-7	NA	NA	1.43E+01
Cadmium	7440-43-9	2.20E+00	1.60E+00	2.36E-03
Carbon disulfide	75-15-0	NA	NA	5.91E-01
Carbon tetrachloride	56-23-5	NA	1.00E+04	9.71E+00
Carbazole	86-74-8	NA	NA	NA
Chlorobenzene	108-90-7	NA	0.05	NA
Chloroethane	75-00-3	NA	NA	NA
Chloroform	67-66-3	NA	1.00E-03	1.54E+01
Chloromethane	74-87-3	NA	NA	NA
Chromium	18540-29-9	3.30E+01	4.00E-01	1.00E+00
Chrysene	218-01-9	NA	NA	NA
Cobalt	7440-48-4	1.10E+01	2.00E+01	4.27E-01
Copper	7440-50-8	2.20E+01	4.00E+01	2.11E+00
Dibenz(a,h)anthracene	53-70-3	NA	NA	NA
Dibenzofuran	132-64-9	NA	NA	NA

Table A-6. (continued).

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
Dibromochloromethane	124-48-1	NA	NA	NA
Dibutylphthalate	84-74-2	NA	2.00E+02	1.50E+01
Diethylphthalate	84-66-2	NA	1.00E+02	1.53E+02
Dimethylphthalate	131-11-3	NA	2.00E+02	NA
Di-n-octylphthalate	117-84-0	NA	NA	4.71E+01
Ethylbenzene	100-41-4	NA	5.00E-02	5.52E+01
Fluoranthene	206-44-0	NA	1.00E-01	3.38E+01
Fluorene	86-73-7	NA	3.00E+01	3.38E+01
Hexachlorobenzene	118-74-1	NA	2.50E-03	NA
Hexachlorobutadiene	87-68-3	NA	NA	NA
Hexachlorocyclopentadiene	77-47-4	NA	1.00E+01	NA
Hexachloroethane	67-72-1	NA	NA	NA
Indeno(1,2,3-cd)pyrene	193-39-5	NA	NA	NA
Iron	7439-89-6	2.40E+04	2.00E+02	NA
Isophorone	78-59-1	NA	NA	NA
Lead	7439-92-1	1.70E+01	5.00E+01	9.94E-01
Magnesium	7439-95-4	1.20E+04	NA	NA
Manganese	7439-96-5	4.90E+02	1.00E+02	1.05E+01
Mercury	7487-94-7	5.00E-02	1.00E-01	3.00E-01
Methylene chloride	75-09-2	NA	2.00E+00	1.00E+00
N-nitroso-di-n-propylamine	621-64-7	NA	NA	NA
N-nitrosodiphenylamine	86-30-6	NA	NA	NA
Naphthalene	91-20-3	NA	1.00E-01	1.43E+00

Table A-6. (continued).

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
Nickel	7440-02-0	3.50E+01	3.00E+01	3.00E+01
Nitrobenzene	98-95-3	NA	4.00E+01	1.95E+00
Pentachlorophenol	87-86-5	NA	2.00E-03	1.30E-01
Phenanthrene	85-01-8	NA	1.00E-01	1.35E+02
Phenol	108-95-2	NA	5.00E-02	8.23E+00
Potassium	7440-09-7	4.30E+03	NA	NA
Pyrene	129-00-0	NA	1.00E-01	4.22E+01
Pyridine	110-86-1	NA	1.00E-01	NA
Selenium	7782-49-2	2.20E-01	8.10E-01	1.72E-01
Silica	7631-86-9	NA	NA	NA
Silver	7440-22-4	NA	2.00E+00	2.00E+00
Sodium	7440-23-5	3.20E+02	NA	NA
Styrene	88671-89-0	NA	1.00E-01	NA
Sulfide	—	NA	NA	NA
Tetrachloroethylene	127-18-4	NA	1.00E-02	3.33E+00
Thallium	7440-28-0	4.30E-01	1.00E+00	1.01E-01
Tin	7440-31-5	NA	5.30E+01	3.73E+00
Toluene	106-88-3	NA	5.00E-02	6.04E+01
Tributylphosphate	126-73-8	NA	NA	3.99E+01
Trichloroethylene	79-01-6	NA	1.00E-03	1.74E+01
Vanadium	7440-62-2	4.50E+01	2.00E+00	1.49E+00
Vinyl chloride	75-01-4	NA	1.00E-02	NA

Table A-6. (continued).

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
Xylene[e]	1330-20-7	NA	5.00E-02	2.78E-01
Zinc	7440-66-6	1.50E+02	5.00E+01	3.29E+00
Ag-108m	14391-65-2	NA	NA	1.82E+03
Ag-110m	14391-76-5	NA	NA	1.08E+03
Am-241	14596-10-2	1.10E-02	NA	1.78E+01
Ce-144	14762-78-8	NA	NA	2.27E+04
Cm-242	15510-73-3	NA	NA	1.60E+01
Cm-243/244	13981-15-2	NA	NA	1.68E+01
Co-58	13981-38-9	NA	NA	3.66E+03
Co-60	10198-40-0	NA	NA	1.18E+03
Cs-134	13967-70-9	NA	NA	1.90E+03
Cs-137	10045-97-3	8.20E-01	NA	4.95E+03
Eu-152	14683-23-9	NA	NA	2.18E+03
Eu-154	15585-10-1	NA	NA	2.48E+03
Eu-155	14391-16-3	NA	NA	3.25E+04
H-3	10028-17-8	NA	NA	3.43E+05
I-129	15046-84-1	NA	NA	4.76E+04
Mn-54	13966-31-9	NA	NA	3.53E+03
Nb-95	13967-76-5	NA	NA	3.56E+03
Ni-63	13981-37-8	NA	NA	1.14E+05
Np-237	13994-20-2	NA	NA	1.94E+01
Pu-238	13981-16-3	4.90E-03	NA	1.78E+01

Table A-6. (continued).

Column number	1	2	3	4
Nonradionuclide COPCs	CAS Number	INEEL Background Concentration (pCi/g or mg/kg) [a]	Region 4 Ecological Soil Screening Levels (pCi/g or mg/kg) [b]	INEEL EBSLs[c]
Pu-239/240	14119-33-6	1.00E-01	NA	1.89E+01
Ra-226	13982-63-3	NA	NA	2.04E+01
Ru-103	13968-53-1	NA	NA	6.38E+03
Ru-106	13967-48-1	NA	NA	1.94E+05
Sb-125	14234-35-6	NA	NA	6.02E+03
Sr-90	10098-97-2	4.90E-01	NA	3.34E+03
U-233/234	13966-29-5	1.44E+00	NA	2.05E+01
U-235	15117-96-1	NA	NA	2.27E+01
U-238	74406-1-1	1.40E+00	NA	2.32E+01
Zn-65	13982-39-3	NA	NA	5.21E+03
Zr-95	13967-71-0	NA	NA	3.69E+03

a. Values were taken from (Rood et al. 1996).
b. Values were taken from (EPA 2000b).
c. Values were taken from (DOE-ID 1999b).
d. The PRGs for 1,3-dichloropropene represents a mixture both the cis and tran version of this chemical.
e. The PRGs for Xylene represent a totals mix of ortho, meta, and para versions of this chemical.