6.0 SCREENING HUMAN HEALTH RISK ASSESSMENT[1]

6.1 INTRODUCTION

This SHHRA documents the chemicals of concern (COCs) that may contribute to potential health risks to humans from exposure to contamination within the Load Line 3 AOC at RVAAP in Ravenna, Ohio. Load Line 3 was used to melt and load Composition B into large-caliber shells and bombs. The line operated during World War II, from 1951 to 1957, and again from 1969 to 1971. During its operation history, Load Line 3 produced about 6.5 million munitions. Demilitarization activities were conducted between 1951 and 1957. Beginning in the early 1950's, the DLA conducted a strategic materials storage mission at Load Line 3. One hundred above-grade storage tanks, having a capacity of 500 barrels (21,000 gal), were constructed to store strategic materials. By the late 1970's all but 20 tanks had been removed. All DLA storage tanks are now empty; the remaining materials were removed approximately 3.5 years ago. This screening risk assessment is prepared in accordance with the *RVAAP's Facility Wide Human Health Risk Assessors Manual* (FWHHRAM) (USACE 2004) as part of the Phase II RI report for the Load Line 3 AOC.

The purpose of this SHHRA is to define the potential for health risks to be associated with various current and future uses of the land at Load Line 3 by identifying COCs and to identify the appropriate RGOs for use in evaluating potential remedial actions.

The process used to accomplish the objectives of this SHHRA is

- identify all COPCs at Load Line 3,
- identify appropriate receptor populations and exposure scenarios for current and future land use at Load Line 3,
- develop screening RGOs for these exposure scenarios for all COPCs identified at Load Line 3,
- identify COCs by comparing Load Line 3 concentrations to screening RGOs, and
- calculate risk-based RGOs for the COCs to move forward to the FS.

The Load Line 3 SHHRA identifies COCs and presents RGOs for five environmental media: groundwater, surface water, sediment, surface soil, and subsurface soil.

This risk assessment is organized into six major sections. The screening process used to identify COPCs is discussed in Section 6.2. The exposure assessment, which is performed to identify the exposure pathways by which receptors may be exposed to contaminants and calculate potential intakes, is presented in Section 6.3. The toxicity assessment for the Load Line 3 COPCs is presented in Section 6.4. The results of the risk characterization (i.e., COCs and RGOs) are presented in Section 6.5. An assessment of the uncertainties associated with the risk characterization is provided in Section 6.6, and the conclusions of the SHHRA are summarized in Section 6.7.

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[1] Chapter 6.0 has been revised in its entirety in this draft revision of the RI.

6.2 DATA EVALUATION

This chapter provides a description of the data evaluation process used to identify COPCs for Load Line 3. The data evaluation process is conducted in accordance with the FWHHRAM (USACE 2004). The purpose of the SHHRA data evaluation screening process is to eliminate chemicals for which no further risk evaluation is needed. Data collected at Load Line 3 are aggregated by environmental medium (i.e., surface water, soil, sediment, and groundwater). Soil data are further aggregated by depth interval—shallow surface soils from 0 to 0.3 m (0 to 1 ft) bgs, deep surface soils from 0 to 1.2 m (0 to 4 ft), and subsurface soil greater than 0.3 m (1 ft) bgs. Due to the presence of shallow bedrock at Load Line 3, subsurface soil samples were taken to a maximum of 0.9 m (3 ft) bgs.

Data for surface and subsurface soils are aggregated into EUs based on historical use and geographic proximity, as described in Section 4.1.2. The purpose of combining areas with similar use and geography is to allow an appropriate assessment of similar exposures over a given EU. If areas with dissimilar histories are aggregated, there is a potential to screen out contaminants that should be carried through the process. The aggregates selected to divide the Load Line 3 AOC into EUs achieve the intent of being protective of human and environmental health. Soil data are grouped into the following seven EUs, which are shown on Figure 4-1:

- Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10),
- Preparation and Receiving Areas Aggregate (Buildings EB-3 and EB-803),
- Packaging and Shipping Areas Aggregate (Buildings EB-11, EB-13A/-13B),
- Change Houses Aggregate,
- DLA Storage Tanks Aggregate,
- West Ditches Aggregate, and
- Perimeter Area Aggregate.

Surface soil samples were collected from all seven EUs; subsurface soil samples were collected only from the Explosives Handling Areas, Preparation and Receiving Areas, and Perimeter Area Aggregates.

Data collected from buildings and structures are not included in the SHHRA. These samples were collected at the same time as the Phase II RI, but were collected for use by decontamination and decommissioning contractors. See Section 4.8 for a detailed discussion of these data.

Surface water and sediment data are aggregated by conveyance. One aggregate, Cobb's Pond Tributary shown in Figure 4-1, was identified at Load Line 3. Dry sediment collected from ditches that are primarily dry is addressed as soil. Water samples from small intermittent ditch lines or puddles do not represent viable habitat and do not fit the exposure models for human receptors to water; these are considered only qualitatively. Samples collected from manholes, sanitary sewers, and storm sewers are not included in the SHHRA.

Groundwater data are represented by a single aggregate, as described in Section 4.1.2.

Section 6.2.1 provides a summary of the COPC selection process and the data assumptions used during that process. Section 6.2.2 presents the results of the COPC screening process.

6.2.1 Chemical of Potential Concern Screening

SRCs that exceed screening levels and potentially pose a risk to human health are called COPCs. This section provides a description of the screening process used to identify COPCs and the data assumptions used in the process.

COPCs are identified for each EU for each medium. This data evaluation consists of five steps: (1) a data quality assessment (DQA), (2) frequency-of-detection/ WOE screening, (3) screening of essential human nutrients, (4) risk-based screening, and (5) background screening.

1. **Data Quality Assessment** – Analytical results were reported by the laboratory in electronic form and loaded into a Load Line 3 database. Site data were then extracted from the database so that only one result is used for each station and depth sampled. QC data, such as sample splits and duplicates, and laboratory re-analyses and dilutions were not included in the determination of COPCs for this risk assessment. Field screening data that were considered in the evaluation of nature and extent of contamination at Load Line 3 are not included in the dataset for the risk assessment. Samples rejected in the validation process are also excluded from the risk assessment. The percentage of rejected data is approximately 1%. A complete summary of data quality issues is presented in the DQA appendix of this report (see Appendix H).

2. **Frequency-of-Detection/Weight-of-Evidence Screen** – Each chemical for each environmental medium was evaluated to determine its frequency of detection. Chemicals that were never detected were eliminated as COPCs. For sample aggregations with at least 20 samples and a frequency of detection of less than 5%, a WOE approach was used to determine if the chemical is AOC-related. The magnitudes and locations (clustering) of the detections and potential source of the chemical were evaluated. If the detected results showed no clustering, the chemical is not a COPC in another medium at that location, the concentrations are not substantially elevated relative to the detection limit, and the chemical was not used in the area under investigation, they are considered spurious, and the chemical was eliminated from further consideration. This screen is applied to all organic and inorganic chemicals with the exception of explosives and propellants. All detected explosives and propellants are included in the list of COPCs regardless of their frequency of detection.

3. **Essential Nutrients** – Chemicals that are considered essential nutrients (i.e., calcium, chloride, iodine, iron, magnesium, potassium, phosphorus, and sodium) are an integral part of the human food supply and are often added to foods as supplements. EPA (1989a) recommends that these chemicals not be evaluated as COPCs so long as they are (1) present at low concentrations (i.e., only slightly elevated above naturally occurring levels) and (2) toxic at very high doses (i.e., much higher than those that could be associated with contact at the site). Recommended daily allowance (RDA) and recommended daily intake (RDI) values are available for seven of these metals. Based on these RDA/RDI values, a receptor ingesting 100 mg of soil per day would receive less than the RDA/RDI of calcium, magnesium, phosphorous, potassium, and sodium, even if the soil consisted of the pure mineral (i.e., soil concentrations > 1,000,000 mg/kg). Receptors ingesting 100 mg of soil per day would require soil concentrations of 1,500 mg/kg of iodine and 100,000 to 180,000 mg/kg of iron to meet their RDA/RDI for these metals. Concentrations of essential nutrients do not exceed these levels at Load Line 3; thus, these constituents are not addressed as COPCs.

4. **Risk-based Screen** – The objective of this evaluation is to identify COPCs that may pose a potentially significant risk to human health. The risk-based screening values are conservative values published by EPA. The MDC of each chemical in each environmental medium is compared against the appropriate risk-based screening value. Chemicals detected below these concentrations are screened from further consideration. Detected chemicals without risk-based screening values are not eliminated from the COPC list. The risk-based screening values for each environmental medium are described in Section 6.2.1.1.

5. **Background Screen** – For each inorganic constituent detected, concentrations in Load Line 3 samples are screened against available, naturally occurring background levels. This screening step, which applies only to the inorganics, is used to determine if detected inorganics are site related or

naturally occurring. If the MDC of a constituent exceeds the background value, the constituent is considered AOC-related. All detected organic compounds are considered to be above background. Inorganic chemicals whose MDCs are below background levels are eliminated from the COPC list. Background screening values are described in Section 6.2.1.2.

6.2.1.1 Risk-based screening values

The risk-based screening values are conservative values published by EPA.

- For surface soil, subsurface soil, and sediment, a conservative screen is performed using the most current residential preliminary remediation goals (PRGs) published by EPA Region 9 (EPA 2002a). To account for the potential effects of multiple chemicals, PRGs based on non-cancer endpoints are divided by 10. These screening values are very conservative [based on a 10^{-6} risk level and a hazard quotient (HQ) of 0.1]. For information purposes only, data from these same media are also compared against the Region 9 industrial soil PRGs. Region 9 PRGs can be found on the EPA Region 9 World Wide Web site (http:/www.epa.gov/region09/waste/sfund/prg/index.html).

- Surface water and groundwater data are screened using the EPA Region 9 tap water PRGs, which are also available at http:/www.epa.gov/region09/waste/sfund/prg/index.html.

6.2.1.2 Background screening values

This Load Line 3 Phase II RI does not include determination of Load Line 3-specific background data. Analytical results are screened against the final facility-wide background values for RVAAP, published in the *Phase II Remedial Investigation Report for Winklepeck Burning Grounds at Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Background values for soil are available for two soil depths: surface (0 to 1 ft bgs) and subsurface (1 to 12 ft bgs). Soil data at Load Line 3 are aggregated into three depth intervals: shallow surface soil (0 to 1 ft bgs), deep surface soil (0 to 4 ft bgs), and subsurface soil (greater than 1 ft bgs). The following background depth intervals are used for identifying COPCs in Load Line 3 soil.

- For shallow surface soil (0 to 1 ft bgs), the background screen is performed using background values for surface soil (0 to 1 ft bgs).

- For deep surface soil (0 to 4 ft bgs), the background screen is performed using background values for either surface soil (0 to 1 ft bgs) or subsurface soil (1 to 12 ft bgs), whichever is lower.

- For subsurface soil (greater than 1 ft bgs), the background screen is performed using background values for subsurface soil (1 to 12 ft bgs).

6.2.1.3 Chemical of potential concern screening assumptions

The data used to determine COPCs may include data collected from both Phase I (as appropriate, see Section 4.1) and Phase II RIs. Specific assumptions applied to these data can be found in Chapter 4.0 (Nature and Extent of Contamination). The following assumptions, used in the development of COPCs for the SHHRA, are noted.

- Physical chemical data (e.g., alkalinity, pH, etc.) are not considered to be COPCs for Load Line 3.

- Filtered data are not used in the determination of surface water COPCs (i.e., only unfiltered data are evaluated for surface water). Unfiltered data include both soluble and insoluble chemicals. These data represent untreated/unprocessed water drawn from a surface water sampling station. However, due to problems with the groundwater samples having high turbidity, filtered metals data for groundwater are used in this risk assessment (Mohr 1998). See Section 4.6 for a detailed discussion on filtered groundwater data.

- Soil data are subdivided into three datasets—shallow surface soil, deep surface soil, and subsurface—based on sampling depths used for Load Line 3. Shallow surface soils were collected from 0 to 1 ft bgs, deep surface soils from 0 to 3 ft bgs, and subsurface soil from 1 to 3 ft bgs.
- Chemicals not detected in a medium are not considered to be COPCs for that medium.
- Alpha-chlordane and gamma-chlordane are evaluated by screening against the EPA Region 9 PRGs for chlordane.

COPCs are determined for each medium in each EU using all available data after the data assumptions listed above are applied.

6.2.2 Chemical of Potential Concern Screening Results

The COPC screening process and results are summarized in Tables Q-1 through Q-6. These tables include

- summary statistics, including frequency of detection, range of detected concentrations, arithmetic average concentration, and UCL_{95} on the mean concentration;
- all screening values (background concentrations and PRGs, as appropriate); and
- final COPC status.

Table 6-1 summarizes the resulting COPCs for each medium/AOC combination. COPCs are categorized as quantitative (based on available toxicity values, these chemicals will be further evaluated quantitatively in this SHHRA) and qualitative (due to a lack of toxicity values these chemicals will be further evaluated quantitatively in this SHHRA); see the Toxicity Assessment (Section 6.4) for more details on toxicity.

6.2.2.1 COPCs for groundwater

As shown in Table 6-1, eight groundwater COPCs were identified at Load Line 3, including one metal (manganese), four explosives (2,4,6-TNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; and RDX), two pesticides (heptachlor epoxide and beta-BHC), and one VOC (carbon tetrachloride). Based on lack of toxicity information, two of these eight COPCs are classified as qualitative COPCs (2-amino-4,6-DNT and 4-amino-2,6-DNT); RGO screening cannot be performed for these two COPCs.

6.2.2.2 COPCs for surface water

As shown in Table 6-1, two metals were identified as surface water COPCs for the Cobb's Pond Tributary aggregate: arsenic and manganese.

6.2.2.3 COPCs for sediment

As shown in Table 6-1, six sediment COPCs were identified for the Cobb's Pond aggregate, including one metal (antimony), one explosive (4-amino-2,6-DNT), one PCB (PCB-1254), and three PAHs

Table 6-1. COPCs for each Medium at Load Line 3[a]

COPC	Groundwater	Surface Water	Sediment	Shallow Surface Soil	Deep Surface Soil	Subsurface Soil
Quantitative COPCs[b]						
Inorganics						
Aluminum				CH,EH,PS	CH,EH,PS	
Antimony			CP	DL,EH,PA,PR,PS,WD	DL,EH,PA,PR,PS,WD	
Arsenic		CP		DL,EH,PA,PR,PS,WD	DL,EH,PA,PR,PS,WD	EH,PA,PR
Barium				EH,PA,PS	EH,PA,PS	
Cadmium				EH,PA,PR,PS	EH,PA,PR,PS	PA
Chromium				EH	EH	
Copper				PR,WD	PR,WD	
Lead				DL,EH,PA,PR,PS,WD	DL,EH,PA,PR,PS,WD	PA
Manganese	LL3	CP		CH,DL,EH,PA,PR,PS,WD	CH,DL,EH,PA,PR,PS,WD	
Thallium				DL,EH,PR	DL,EH,PR	
Zinc				EH	EH	
Organics						
1,3-Dinitrobenzene				EH	EH	EH
2,4,6-Trinitrotoluene	LL3			EH,PS,WD	EH,PA,PS,WD	EH,PA
2,4-Dinitrotoluene				EH,PS	EH,PS	EH
2-Methylnaphthalene				EH	EH	
4,4'-DDE				PA	PA	
Benz(*a*)anthracene				EH,PA,WD	EH,PA,WD	
Benzo(*a*)pyrene			CP	EH,PA,PR,PS,WD	EH,PA,PR,PS,WD	
Benzo(*b*)fluoranthene				EH,PA,PR,WD	EH,PA,PR,WD	
Benzo(*k*)fluoranthene				EH	EH	
Carbon Tetrachloride	LL3					
Dibenz(*a,h*)anthracene				EH,PA,PR,WD	EH,PA,PR,WD	
Dieldrin				EH,WD	EH,WD	
Endrin				EH	EH	
Heptachlor				EH,PA	EH,PA	
Heptachlor Epoxide	LL3			EH	EH	
Indeno(1,2,3-*cd*)pyrene				EH,WD	EH,WD	

Table 6-1. COPCs for each Medium at Load Line 3[a] (continued)

COPC	Groundwater	Surface Water	Sediment	Shallow Surface Soil	Deep Surface Soil	Subsurface Soil
PCB-1254			CP	CH,EH,PA,PR,PS,WD	CH,EH,PA,PR,PS,WD	EH
PCB-1260				EH,PR	EH,PR	
RDX	LL3			EH,PA,PR	EH,PA,PR	PA
beta-BHC	LL3					
Qualitative COPCs[c]						
Organics						
2-Amino-4,6-Dinitrotoluene	LL3			EH,PA,PR,WD	EH,PA,PR,WD	EH,PA
4-Amino-2,6-Dinitrotoluene	LL3		CP	EH,PA,PR,WD	EH,PA,PR,WD	EH,PA
Acenaphthylene				EH,WD	EH,WD	
Benzo(*g,h,i*)perylene			CP	EH,PA,PR,PS,WD	EH,PA,PR,PS,WD	
Nitrocellulose				EH,PA,PR	EH,PA,PR	
Phenanthrene			CP	DL,EH,PA,PR,PS,WD	DL,EH,PA,PR,PS,WD	

[a] COPCs are shown for all medium/area of concern combinations. Area of concern codes are as follows:
LL3 = Load Line 3.
CH = Change Houses Aggregate.
CP = Cobb's Pond Tributary Aggregate.
DL = DLA Tanks Aggregate.
EH = Explosives Handling Areas Aggregate.
PA = Perimeter Area Aggregate.
PR = Preparation and Receiving Areas Aggregate.
PS = Packaging and Shipping Areas Aggregate.
WD = West Ditches Aggregate.
[b] Quantitative COPCs have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
[c] Qualitative COPCs do not have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
BHC = Benzene hexachloride.
COPC = Chemical of potential concern.
DDE = Dichlorodiphenyldichloroethylene.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

[benzo(*a*)pyrene, benzo(*g,h,i*)perylene, and phenanthrene]. Based on lack of toxicity information, three of these six COPCs are classified as qualitative COPCs (4-amino-2,6-DNT, benzo(*g,h,i*)perylene, and phenanthrene); RGO screening cannot be performed for these two COPCs.

6.2.2.4 COPCs for shallow surface soil

As seen in Table 6-1, a total of 35 COPCs were identified within the seven shallow surface soil aggregates. The 35 shallow surface soil COPCs include:

- 11 metals (aluminum, antimony, arsenic, barium, cadmium, total chromium, copper, lead, manganese, thallium, and zinc);
- 7 explosives (1,3-DNB; 2,4,6-TNT; 2,4-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; and RDX);
- 5 pesticides (4,4'-DDE; dieldrin; endrin; heptachlor; and heptachlor epoxide);
- 8 PAHs [benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*g,h,i*)perylene, benzo(*k*)fluoranthene, dibenz(*a,h*)anthracene, indeno(*1,2,3-cd*)pyrene, and phenanthrene];
- 2 PCBs (PCB-1254 and PCB-1260); and
- 2 SVOCs (2-methylnaphthalene and acenaphthylene).

Based on lack of toxicity information, 6 of these 35 shallow surface soil COPCs are classified as qualitative COPCs [2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; benzo(*g,h,i*)perylene; phenanthrene; and acenaphthylene]; RGO screening cannot be performed for these six COPCs.

6.2.2.5 COPCs for deep surface soil

As seen in Table 6-1, a total of 35 COPCs were identified within the seven deep surface soil aggregates. The 35 deep surface soil COPCs include:

- 11 metals (aluminum, antimony, arsenic, barium, cadmium, total chromium, copper, lead, manganese, thallium, and zinc);
- 7 explosives (1,3-DNB; 2,4,6-TNT; 2,4-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; and RDX);
- 5 pesticides (4,4'-DDE; dieldrin; endrin; heptachlor; and heptachlor epoxide);
- 8 PAHs [benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*g,h,i*)perylene, benzo(*k*)fluoranthene, dibenz(*a,h*)anthracene, indeno(*1,2,3-cd*)pyrene, and phenanthrene];
- 2 PCBs (PCB-1254 and PCB-1260); and
- 2 SVOCs (2-methylnaphthalene and acenaphthylene).

Based on lack of toxicity information, 6 of these 35 deep surface soil COPCs are classified as qualitative COPCs [2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; benzo(*g,h,i*)perylene; phenanthrene; and acenaphthylene]; RGO screening cannot be performed for these six COPCs.

6.2.2.6 COPCs for subsurface soil

A total of 10 COPCs were identified in three subsurface soil aggregates (Explosives Handling Areas, Preparation and Receiving Areas, and Perimeter Area); see Table 6-1. The 10 subsurface soil COPCs include:

- 3 metals (arsenic, cadmium, and lead);
- 6 explosives (1,3-DNB; 2,4,6-TNT; 2,4-DNT; 2-amino-4,6-DNT; 4-amino-2,6-DNT; and RDX); and
- 1 PCB (PCB-1254).

Based on lack of toxicity information, 2 of these 10 subsurface soil COPCs are classified as qualitative COPCs (2-amino-4,6-DNT and 4-amino-2,6-DNT); RGO screening cannot be performed for these two COPCs.

6.3 EXPOSURE ASSESSMENT

The objectives of the exposure assessment are to estimate the magnitude, frequency, and duration of potential human exposure to COPCs. The four primary steps of the exposure assessment for this SHHRA are listed below.

1. Characterize the proposed land use to identify the potentially exposed human receptors, their activity patterns, and any other characteristics that might increase or decrease their likelihood of exposure.

2. Identify each exposure pathway by which a receptor may be exposed to the COPCs (e.g., surface water ingestion).

3. Identify exposure parameters (e.g., ingestion rate) for each receptor's potential intake of each COPC.

4. Identify the concentrations of COPCs to which the receptors may be exposed.

In this SHHRA the output of the exposure assessment is used in conjunction with the output of the toxicity assessment (Section 6.4) for the development of screening RGOs to identify COCs in the risk characterization (Section 6.5).

6.3.1 Land Use and Potential Receptors

The RVAAP installation is located in two counties of northeastern Ohio, Portage County and Trumbull County, with a majority of the facility lying in Portage County. According to the 2000 Census, the total population of Portage and Trumbull counties was 152,061 and 225,116, respectively. The largest population centers in the area are the towns of Ravenna (population 11,771), which is located approximately 2 miles to the west, and Newton Falls (population 5,002), which is located approximately 1 mile to the southwest.

The land use immediately surrounding the facility is primarily rural. Approximately 55% of Portage County is either woodland or farmland (Portage County Soil and Water Conservation District Resources Inventory 1985; Census Bureau 1992). To the south of the facility is the Michael J. Kirwan Reservoir, which is used for recreational purposes. The Reservoir is south of the site, across State Route 5. The Reservoir is fed by the West Branch of the Mahoning River, which flows south along the western edge of the installation. Hinkley Creek flows south across the western portion of the facility and eventually flows into the West Branch of the Mahoning River. The major surface drainages at RVAAP—Sand Creek and the South Fork of Eagle Creek—exit the facility property and eventually flow east to the Mahoning River.

Residential groundwater use occurs outside of the facility, with most of the residential wells tapping into either the Sharon Conglomerate or the surficial unconsolidated aquifer. Groundwater from on-site production wells was used during operations at the facility (USACE 1996); however, all but two of these production wells have been abandoned. In addition, there is a well located at Building T-5301 that may be utilized for future IRP projects for sanitary water. These wells, located in the central portion of the facility, provide sanitary water to the facility. The Sharon Conglomerate is the major producing aquifer at the facility. The chemicals detected in the soils at Load Line 3 during the Phase I and II RIs are generally explosives and metals. Fate and transport modeling results indicate that none of these metals or explosives, except for RDX, is expected to migrate to any of the receptor locations (see Chapter 5.0 for more information). In addition, groundwater sampling of selected residential wells adjacent to RVAAP, conducted by the Ohio EPA during 1997, found no indications of explosives in groundwater at the locations sampled.

Currently, surface water is used primarily by wildlife; however, some fishing may occur at Cobb's Pond. Cobb's Pond is currently designated as limited "catch and release" and "no wading" (OHARNG 2001).

Land use within the facility is restricted access. In 1993, the land use changed from "maintained caretaker" status to "inactive-modified (un-maintained) caretaker" status (Department of the Army, Environmental Assessment 1993). This new status indicated that the facility was no longer needed to mobilize for war efforts. The only remaining federally mandated mission for the facility was identified as ammunition and bulk explosives storage. Funding decreased for building maintenance and maintenance activities such as mowing. Load Line 3, which lies in the eastern portion of the facility, is outside of any of the existing ammunition storage areas. The facility is currently maintained by a contracted caretaker, Tol-Test, Inc. Site workers infrequently visit the load line, and mowing no longer takes place. RVAAP occupies parts of the Ravenna Training and Logistics Site (RTLS). OHARNG conducts training exercises in parts of the RTLS. Training is restricted to areas outside of AOCs. No training is conducted within Load Line 3.

RVAAP is located in a rural area, is not accessible to the general public, and is not near any major industrial or developed areas. The facility is completely fenced and patrolled by security personnel. Army and full-time operating contractor staff (i.e., security and grounds and maintenance workers) are located on-site. Additional subcontractor staff are on-site for varying periods of time, ranging from several weeks to more than 12 months, to complete specific demolition/decommissioning projects. Training activities under OHARNG involve an average of 4,500 personnel during the course of a month, who are on-site for periods of 3 days (inactive duty or weekend training) to 2 weeks (annual training).

Load Line 3 is located in the southeastern corner of RVAAP and is not currently used for OHARNG training activities. Some workers will be present during future demolition activities, which are currently suspended pending additional funding and desensitization of buildings for explosive compounds. The former production area is surrounded by a security fence and locked gates. Groundskeeping activities are limited to infrequent mowing and brush clearing along the perimeter areas outside of the AOC boundary fence. Some areas of RVAAP are used for 6 to 12 deer hunts held each year on Saturdays in October and November. Load Line 3 is not presently included in the deer hunting program. Security activities consist of gate checks and surveillance along Load Line 3 Road.

As described above, there is currently no human activity at Load Line 3 beyond occasional visits by remediation contractors. Therefore, this SHHRA focuses on the potential future land use at Load Line 3. Per the FWHHRAM (USACE 2004), the following potential human receptors are identified for three future land uses at Load Line 3:

- National Guard use includes three receptor types: National Guard Trainee, National Guard Security Guard/Maintenance Worker, and National Guard Fire/Dust Suppression Worker.
- Recreational use includes a receptor engaged in hunting, trapping, and fishing.
- Residential use is included to provide a baseline scenario for unrestricted re-use and evaluates a Resident Subsistence Farmer (adult and child).

6.3.2 Exposure Pathways

An exposure pathway is made up of the following components:

- source,
- release mechanism (e.g., volatilization),
- transport pathway,
- exposure point,
- exposure route, and
- receptor.

Potential exposure pathways associated with each receptor and land use category are identified in Table 6-2. For a baseline ecological risk assessment (BERA), ingestion of food (including fish, waterfowl, venison, beef, and vegetables) raised on-site is included for additional information in the exposure assessment for some of these receptors. However, these indirect pathways are extremely conservative and are not used in the calculation of RGOs.

A discussion of each land use/receptor/pathway combination is provided below. The exposure parameters for each pathway are provided in Table 6-3.

6.3.2.1 National Guard land use

National Guard receptors are assumed to be exposed to four media: soil, surface water, sediment, and groundwater.

Three receptor categories have been identified under this land use. Each of these receptors is described below. Parameter values used to evaluate the National Guard receptors in this SHHRA are provided in Table 6-3.

National Guard Trainee

National Guard Trainees may be present at the site up to 24 hr/d for 24 d/year on inactive duty training and/or 24 hr/d for 15 d/year during annual training. As a conservative estimate for this SHHRA, it is assumed that the same individual is present at Load Line 3 for both inactive duty training (24 d/year) and annual training (15 d/year) for a total exposure frequency of 39 d/year.

Table 6-2. Receptors and Exposure Pathways for RVAAP Load Line 3

Exposure Pathways	Exposure Media					
	Groundwater	Surface Water	Sediment	Surface Soil Shallow[a]	Surface Soil Deep[b]	Subsurface Soil[c]
National Guard – Trainee						
Ingestion	✔	✔	✔	--	✔	--
Dermal	✔	✔	✔	--	✔	--
Inhalation						
Vapor	✔	--[d]	✔	--	✔	--
Dust	--	--	✔	--	✔	--
National Guard – Security Guard/Maintenance Worker						
Ingestion	--	--	--	✔	--	--
Dermal	--	--	--	✔	--	--
Inhalation						
Vapor	--	--	--	✔	--	--
Dust	--	--	--	✔	--	--
National Guard – Fire/Dust Suppression Worker						
Ingestion	--	✔	✔	✔	--	--
Dermal	--	✔	✔	✔	--	--
Inhalation						
Vapor	--	--[d]	✔	✔	--	--
Dust	--	--	✔	✔	--	--
Hunter/Trapper/Fisher						
Ingestion	--	✔	✔	✔	--	--
Dermal	--	✔	✔	✔	--	--
Inhalation						
Vapor	--	--[d]	✔	✔	--	--
Dust	--	--	✔	✔	--	--
Resident Subsistence Farmer (adult and child)						
Ingestion	✔	✔	✔	✔	--	✔
Dermal	✔	✔	✔	✔	--	✔
Inhalation						
Vapor	✔	--[d]	✔	✔	--	✔
Dust	--	--	✔	✔	--	✔

✔ = Receptor is exposed to chemicals of potential concern (COPCs) in this exposure medium.
-- = Receptor is not exposed to COPCs in this exposure medium.
[a] Shallow surface soil is defined as 0 to 1 ft below ground surface (bgs).
[b] Deep surface soil is defined as 0 to 4 ft bgs. However, the maximum sampling depth is 3 ft bgs due to shallow bedrock.
[c] Subsurface soil is defined as 1 to 3 ft bgs.
[d] No volatile organic compounds are COPCs in Load Line 3 surface water.
RVAAP = Ravenna Army Ammunition Plant.

This receptor is assumed to belong to the National Guard for 25 years (default worker exposure duration) and to use Load Line 3 for training every year of his/her enlistment.

It is assumed that Load Line 3 will be used for mounted training. Digging and occupying fighting positions, tank defilade positions, tank ditches, and battle positions that extend below ground surface will be prohibited. Tracked and wheeled operations may result in maneuver damage up to 4 ft bgs. Because of this maneuver damage, the National Guard Trainee is assumed to be exposed to deep surface soil defined as 0 to 4 ft bgs. Due to the presence of shallow bedrock at Load Line 3, soil samples were taken to a maximum depth of 3 ft bgs. This receptor is exposed to soil via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust.

Table 6-3. Parameters Used to Quantify Exposures for Each Medium and Receptor at Load Line 3[a]

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel			Recreator	Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker	Dust/Fire Control	Trainee	Hunter/ Fisher	Adult	Child
Surface Soil[b]							
Incidental Ingestion							
Soil ingestion rate	kg/d	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Exposure time	hr/d	1	4	24	4.57	24	24
Exposure frequency	d/year	250	15	39	7	350	350
Exposure duration	years	25	25	25	30	30	6
Body weight	kg	70	70	70	70	70	15
Carcinogen averaging time	d	25,550	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	9,125	9,125	9,125	10,950	10,950	2,190
Fraction ingested	Unitless	1	1	1	1	1	1
Conversion factor	d/h	0.042	0.042	0.042	0.042	0.042	0.042
Dermal Contact							
Skin area	m^2/event	0.33	0.33	0.33	0.57	0.57	0.22
Adherence factor	mg/cm^2	0.7	0.3	0.3	0.3	0.4	0.2
Absorption fraction	Unitless	**Chemical Specific – See Table Q-7**					
Exposure frequency	events/year	250	15	39	7	350	350
Exposure duration	years	25	25	25	30	30	6
Body weight	kg	70	70	70	70	70	15
Carcinogen averaging time	d	25,550	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	9,125	9,125	9,125	10,950	10,950	2,190
Conversion factor	(kg-cm^2)/(mg-m^2)	0.01	0.01	0.01	0.01	0.01	0.01
Inhalation of VOCs and Dust							
Inhalation rate	m^3/d	20	44.4	44.4	20	20	10
Exposure time	hr/d	1	4	24	4.57	24	24
Exposure frequency	d/year	250	15	39	7	350	350
Exposure duration	years	25	25	25	30	30	6

Table 6-3. Parameters Used to Quantify Exposures for Each Medium and Receptor at Load Line 3[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel			Recreator	Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker	Dust/Fire Control	Trainee	Hunter/ Fisher	Adult	Child
Body weight	kg	70	70	70	70	70	15
Carcinogen averaging time	d	25,550	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	9,125	9,125	9,125	10,950	10,950	2,190
Conversion factor	d/hr	0.042	0.042	0.042	0.042	0.042	0.042
Subsurface Soil							
Incidental Ingestion							
Soil ingestion rate	kg/d	NA	NA	NA	NA	0.0001	0.0002
Exposure time	hr/d	NA	NA	NA	NA	24	24
Exposure frequency	d/year	NA	NA	NA	NA	350	350
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	d	NA	NA	NA	NA	25,550	25,550
Noncarcinogen averaging time	d	NA	NA	NA	NA	10,950	2,190
Fraction ingested	Unitless	NA	NA	NA	NA	1	1
Conversion factor	d/h	NA	NA	NA	NA	0.042	0.042
Dermal Contact							
Skin area	m^2/event	NA	NA	NA	NA	0.57	0.22
Adherence factor	mg/cm^2	NA	NA	NA	NA	0.4	0.2
Absorption fraction	Unitless	NA	NA	NA	NA	**Chem. Spec. See Table Q-7**	
Exposure frequency	events/year	NA	NA	NA	NA	350	350
Exposure duration	years	NA	NA	NA	NA	30	6
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	d	NA	NA	NA	NA	25,550	25,550
Noncarcinogen averaging time	d	NA	NA	NA	NA	10,950	2,190
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	NA	NA	NA	NA	0.01	0.01
Inhalation of VOCs and Dust							
Inhalation rate	m^3/d	NA	NA	NA	NA	20	10
Exposure time	hr/d	NA	NA	NA	NA	24	24
Exposure frequency	d/year	NA	NA	NA	NA	350	350
Exposure duration	years	NA	NA	NA	NA	30	6

Table 6-3. Parameters Used to Quantify Exposures for Each Medium and Receptor at Load Line 3[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel			Recreator	Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker	Dust/Fire Control	Trainee	Hunter/ Fisher	Adult	Child
Body weight	kg	NA	NA	NA	NA	70	15
Carcinogen averaging time	d	NA	NA	NA	NA	25,550	25,550
Noncarcinogen averaging time	d	NA	NA	NA	NA	10,950	2,190
Conversion factor	d/hr	NA	NA	NA	NA	0.042	0.042
Sediment							
Incidental Ingestion							
Soil ingestion rate	kg/d	NA	0.0001	0.0001	0.0001	0.0001	0.0002
Exposure time	hr/d	NA	4	24	4.57	24	24
Exposure frequency	d/year	NA	15	39	7	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	d	NA	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	NA	9,125	9,125	10,950	10,950	2,190
Fraction ingested	Unitless	NA	1	1	1	1	1
Conversion factor	d/hr	NA	0.042	0.042	0.042	0.042	0.042
Dermal Contact							
Skin area	m^2/event	NA	0.33	0.33	0.52	0.57	0.22
Adherence factor	mg/cm^2	NA	0.3	0.3	0.3	0.4	0.2
Absorption fraction	Unitless	NA	**Chemical Specific – See Table Q-7**				
Exposure frequency	events/year	NA	15	39	7	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	d	NA	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	NA	9,125	9,125	10,950	10,950	2,190
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	NA	0.01	0.01	0.01	0.01	0.01
Inhalation of VOCs and Dust							
Inhalation rate	m^3/d	NA	44.4	44.4	20	20	10
Exposure time	hr/d	NA	4	24	4.57	24	24
Exposure frequency	d/year	NA	15	39	7	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15

Table 6-3. Parameters Used to Quantify Exposures for Each Medium and Receptor at Load Line 3[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel			Recreator	Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker	Dust/Fire Control	Trainee	Hunter/ Fisher	Adult	Child
Carcinogen averaging time	d	NA	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	NA	9,125	9,125	10,950	10,950	2,190
Conversion factor	d/hr	NA	0.042	0.042	0.042	0.042	0.042
Surface Water							
Incidental Ingestion							
Incidental water ingestion rate	L/d	NA	0.1	0.1	0.05	0.1	0.1
Exposure frequency	d/year	NA	15	39	7	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	d	NA	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	NA	9,125	9,125	10,950	10,950	2,190
Dermal Contact							
Skin area	m^2	NA	0.33	0.33	0.52	0.57	0.22
Permeability constant	cm/hr	NA	**Chemical Specific – See Table Q-7**				
Exposure time	h/d	NA	4	24	4.57	2.5	2.5
Exposure frequency	d/year	NA	15	39	7	350	350
Exposure duration	years	NA	25	25	30	30	6
Body weight	kg	NA	70	70	70	70	15
Carcinogen averaging time	d	NA	25,550	25,550	25,550	25,550	25,550
Noncarcinogen averaging time	d	NA	9,125	9,125	10,950	10,950	2,190
Conversion factor	$(m/cm)/(L/m^3)$	NA	10	10	10	10	10
Groundwater							
Drinking Water Ingestion							
Drinking water ingestion rate	L/d	NA	NA	2	NA	2	1.5
Exposure frequency	d/year	NA	NA	39	NA	350	350
Exposure duration	years	NA	NA	25	NA	30	6
Body weight	kg	NA	NA	70	NA	70	15
Carcinogen averaging time	d	NA	NA	25,550	NA	25,550	25,550
Noncarcinogen averaging time	d	NA	NA	9,125	NA	10,950	2,190
Dermal Contact While Showering							
Skin area	m^2	NA	NA	1.94	NA	1.94	0.866

Table 6-3. Parameters Used to Quantify Exposures for Each Medium and Receptor at Load Line 3[a] (continued)

Exposure Pathway and Parameter	Units	Potential Receptor					
		National Guard Personnel			Recreator	Resident Subsistence Farmer	
		Security Guard/ Maintenance Worker	Dust/Fire Control	Trainee	Hunter/ Fisher	Adult	Child
Permeability constant	cm/hr	NA	NA	**Chem. Spec. – See Table Q-7**	NA	**Chem. Spec. – See Table Q-7**	
Exposure time	hr/d	NA	NA	0.25	NA	0.25	0.25
Exposure frequency	d/year	NA	NA	39	NA	350	350
Exposure duration	years	NA	NA	25	NA	30	6
Body weight	kg	NA	NA	70	NA	70	15
Carcinogen averaging time	d	NA	NA	25,550	NA	25,550	25,550
Noncarcinogen averaging time	d	NA	NA	9,125	NA	10,950	2,190
Conversion factor	$(m/cm)/(L/m^3)$	NA	NA	10	NA	10	10
Inhalation of VOCs During Household Water Use							
Inhalation rate	m^3/d	NA	NA	20	NA	20	10
Exposure frequency	d/year	NA	NA	39	NA	350	350
Exposure duration	years	NA	NA	25	NA	30	6
Body weight	kg	NA	NA	70	NA	70	15
Carcinogen averaging time	d	NA	NA	25550	NA	25,550	25,550
Noncarcinogen averaging time	d	NA	NA	9125	NA	10,950	2,190[b]
Volatilization factor	L/m^3	NA	NA	0.5	NA	0.5	0.5

[a] Exposure parameter from *RVAAP's Facility Wide Human Health Risk Assessor Manual* (USACE 2004).
[b] Deep (0 to 4 ft bgs) surface soil is used for National Guard Trainee; shallow (0 to 1 ft bgs) surface soil is used for all other receptors.
bgs = Below ground surface.
NA = Not applicable for this scenario.
VOC = Volatile organic compound.

The National Guard Trainee is also assumed to be exposed to surface water and sediment during training. Exposure to these media is assumed to occur daily (i.e., 39 d/year) via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust. According to RTLS staff, all potable water will come from the local municipal water supply. There are currently no plans to obtain potable water from groundwater wells. However, groundwater may be used in the future at vehicle wash points. Groundwater is included as a conservative assumption since the municipal water supply is not currently in place.

National Guard Security Guard/Maintenance Worker

The Load Line 3 area is not mowed. Security patrols occur daily across the installation, but not within Load Line 3; patrolmen usually remain within their vehicles during these patrols. Although the security guard is not currently exposed to contaminated media at Load Line 3 on a daily basis, the potential exposure of this receptor is evaluated in this SHHRA. Therefore, as a worst-case assumption, it is assumed that a security guard leaves his or her vehicle on a daily basis and is exposed to surface soil. Parameter values used to assess exposure to this receptor in the SHHRA are provided in Table 6-3.

National Guard Fire/Dust Suppression Worker

National Guard personnel may use surface water for fire suppression with a frequency of 4 hr/d for 5 d/year (for a total of 20 hr/year), as well as dust suppression for up to 40 hr/year. It is assumed that both of these activities will be conducted by the same individual for a total exposure period of 60 hr/year or approximately 4 hr/d for 15 d/year.

Use of surface water for fire and dust suppression is assumed to result in exposure to surface water via incidental ingestion and dermal contact while setting pumps and hoses in the surface water body and while spraying water. While no VOCs were identified as COPCs in surface water for Load Line 3, it is possible that some inhalation of airborne surface water may occur as a result of spraying. Inhalation is not included in the surface water exposure model; however, the surface water ingestion rate (100 mL/d) is assumed to include potential incidental inhalation exposure.

This receptor is also assumed to be exposed to shallow surface soil and sediment via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust.

6.3.2.2 Recreational land use

In the future, permitted recreational activities at Load Line 3 may include waterfowl hunting, trapping, and fishing. These activities are evaluated for a single recreational receptor, as described below. Parameter values used to evaluate the Recreational receptor in this SHHRA are provided in Table 6-3.

Hunting and Trapping

Permitted waterfowl hunting is managed jointly by the facility staff and the State Division of Wildlife. Waterfowl hunters may be on-site to hunt 4 hr/d for 2 d/year and to check and clean wood duck boxes 1 hr/d for 1 d/year for a total of approximately 9 hr/year.

Trapping takes place 3 months of the year (November through January), primarily to control beaver and raccoon populations. Trappers are assumed to be present at Load Line 3 for 2 hr at the start of the season to scout and set traps and 0.5 rh/d for 6 d/year to check traps, for a total of approximately 5 hr/year. Traps are generally set near ponds (near existing dams) and along roadsides. According to Tim Morgan, OSC forester, the most common catches include beaver, mink, muskrat, weasel, raccoon, possum, rabbit, and squirrel (Morgan 2002).

It is assumed that waterfowl hunting and trapping are conducted by the same individual for a total exposure period of approximately 12 hr/year (evaluated as 6 hr/d for 2 d/year). This receptor is assumed to be exposed to shallow surface soil, surface water, and sediment via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust.

Fishing

Catch and release fishing is allowed at some areas, including Upper and Lower Cobb's Pond, for personnel permanently assigned to RTLS and their guests (OHARNG 2001). Fishers are assumed to be present up to 4 hr/d for 5 d/year. This receptor is assumed to be exposed to shallow surface soil, surface water, and sediment via incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust. It is the goal, when the installation restoration program is done, to have unrestricted fishing and taking of fish from all ponds.

For this SHHRA, it is assumed that hunting, trapping, and fishing are conducted by the same individual for a total exposure period of 4.57 hr/d, 7 d/year (i.e., 6 hr/d for 2 d/year to hunt and trap plus 4 hr/d for 5 d/year to fish).

6.3.2.3 Residential land use

This land use scenario represents a true baseline assessment against which all decisions, including decisions to maintain institutional controls, can be made. The residential scenario was evaluated for unrestricted re-use of the site and to address OHARNG concerns of not wanting any restrictions on the re-use of the property. The adult and child resident farmer are assumed to be exposed chronically to all media: groundwater, surface water, sediment, and soil. It is assumed that the farmer lives on Load Line 3 land and digs into subsurface soils (see Table 6-3). Parameters used to represent activity patterns are listed in Table 6-3 and generally come from standard default values defined by the EPA (1991a).

6.3.3 Exposure Equations

Intake is defined as the amount of contaminant that could be in contact with the body (e.g., lungs and gut) per unit body weight per unit time. Dose is defined as the amount of contaminant that could be absorbed into the bloodstream per unit body weight per unit time. For this SHHRA, intake is not quantified, rather the intake equations as presented in the FWHHRAM (USACE 2004) are modified as shown below to serve as the basis for determining screening RGOs (see more details on the process of determining RGOs in Section 6.5). The exposure parameters used in these equations are provided in Table 6-3. Parameter values, based on EPA guidance with input from the OHARNG and RVAAP facility staff, are taken from the FWHHRAM (USACE 2004).

In general, intake is calculated as shown in Equation 6-1:

$$\text{Intake (mg/kg-d)} = C \times E \,, \qquad \textbf{(6-1)}$$

where

C = chemical concentration in exposure medium (mg/kg in soil and sediment or mg/L in groundwater and surface water),
E = chemical exposure (1/d in soil and sediment or L/kg-d in groundwater and surface water).

The exposure (E) term in this equation is calculated per the equations presented in the FWHHRAM (USACE 2004) for intake, with the concentration term (C) removed. These exposure equations are shown below as Equations 6-2 through 6-7; these exposure equations will subsequently be used in the development of RGOs.

Because RGOs are quantified for direct exposure pathways only, exposure equations are not provided in this SHHRA for the ingestion of food pathways (i.e., fish ingestion by the hunter/trapper/fisher and resident, as well as the ingestion of beef, milk, vegetables, and venison by the resident).

6.3.3.1 Soil and sediment exposure equations

Exposure from the incidental ingestion of soil and sediment is quantified in the RGO calculations using Equation 6-2:

$$\textit{Chemical Exposure } (1/d) = \frac{IR_s \times EF \times ED \times FI \times ET \times CF}{BW \times AT}, \quad \textbf{(6-2)}$$

where

- IR_s = ingestion rate (kg/d),
- EF = exposure frequency (d/year),
- ED = exposure duration (years),
- FI = fraction ingested (value of 1, unitless),
- ET = exposure time (hr/d),
- CF = conversion factor for ET (d/hr),
- BW = body weight (kg),
- AT = averaging time (days) for carcinogens or noncarcinogens.

Exposure for the dermal contact with soils and sediment pathway is quantified in the RGO calculations using Equation 6-3.

$$\textit{Chemical Exposure } (1/d) = \frac{CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT}, \quad \textbf{(6-3)}$$

where

- CF = conversion factor [(10^{-6} kg/mg) × (10^4 cm^2/m^2)],
- SA = skin surface area exposed to soil or sediment (m^2/event),
- AF = soil to skin adherence factor (mg/cm^2),
- ABS = chemical-specific absorption factor [(unitless) Table Q-7; when chemical-specific values are not available, the following defaults are used: 0.1% for inorganics, 1.0% for VOCs, and 10% for SVOCs],
- EF = exposure frequency (events/year),
- ED = exposure duration (years),
- BW = body weight (kg),
- AT = averaging time (days) for carcinogens or noncarcinogens.

Exposure for the inhalation of soil or dry sediment is quantified in the RGO calculations using Equation 6-4:

$$Chemical\ Exposure\ (1/d) = \frac{IR_a \times EF \times ED \times (VF^{-1} + PEF^{-1}) \times ET \times CF}{BW \times AT}, \qquad \textbf{(6-4)}$$

where

IR_a = inhalation rate (m^3/d),
EF = exposure frequency (d/year),
ED = exposure duration (years),
VF = chemical-specific volatilization factor (Table Q-7; m^3/kg),
PEF = particulate emission factor (m^3/kg),
ET = exposure time (hr/d),
CF = conversion factor for ET (d/hr),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or noncarcinogens.

The general PEF value used for all Load Line 3 receptors, except the National Guard Trainee, is the default value for Cleveland, Ohio, assuming a 0.5-acre source area (9.24E+08 m^3/kg). This PEF value was calculated using the EPA Soil Screening Guidance (EPA 1996b), found on-line at http://risk.lsd.ornl.gov/epa/ssl1.shtml. While some of the EUs are smaller than 0.5 acres and some are larger than 0.5 acres, the contamination tends to be limited to small areas around the buildings. Therefore, a 0.5-acre contaminated source area is considered appropriate. A smaller PEF value (1.67×10^6) is used for the National Guard Trainee scenario because the activities of this receptor are assumed to generate more dust. This PEF value was calculated from a dust-loading factor (DLF) of 600 $\mu g/m^3$ (DOE 1983) as: PEF = 1/(DLF × Conversion Factor) = 1/(600 $\mu g/m^3$ × 1E-09 kg/µg) = 1.67E+06 m^3/kg.

6.3.3.2 Groundwater and surface water exposure equations

Exposure for the ingestion of water is quantified in the RGO calculations using Equation 6-5:

$$Chemical\ Exposure\ (L/kg-d) = \frac{IR_w \times EF \times ED}{BW \times AT}, \qquad \textbf{(6-5)}$$

where

IR_w = ingestion rate (L/d),
EF = exposure frequency (d/year),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or noncarcinogens.

Exposure for the dermal contact with chemicals in water is quantified in the RGO calculations using Equation 6-6:

$$Chemical\ Exposure\ (L/kg-d) = \frac{CF \times PC \times SA \times ET \times EF \times ED}{BW \times AT}, \qquad \textbf{(6-6)}$$

where

CF = conversion factor [(m/100 cm) × (1,000 L/m^3)],
PC = chemical-specific permeability constant (Table Q-7; cm/hr),
SA = skin surface area exposed to soil (m^2),
ET = exposure time (hr/d),
EF = exposure frequency (d/year),
ED = exposure duration (years),
BW = body weight (kg),
AT = averaging time (days) for carcinogens and noncarcinogens.

Inhalation of VOCs from surface water is not evaluated because no volatile COPCs have been identified in surface water for Load Line 3. Exposure for the inhalation of VOCs from groundwater during household water use is quantified in the RGO calculations using Equation 6-7:

$$Chemical\ Exposure\ (L/kg-d) = \frac{IR_w \times K \times EF \times ED \times ET \times CF}{BW \times AT}, \quad \textbf{(6-7)}$$

where

IR_w = inhalation rate (m^3/d),
K = volatilization factor (0.0005 × 1,000 L/m^3),
EF = exposure frequency (d/year),
ED = exposure duration (years),
ET = exposure time adjustment (hr/d),
CF = conversion factor for ET (d/hr),
BW = body weight (kg),
AT = averaging time (days) for carcinogens or noncarcinogens.

6.3.4 Exposure Point Concentrations

The exposure point concentration (EPC) represents the chemical concentration a receptor is likely to come in contact with over the duration of exposure. Exposure concentrations from direct contact with environmental media (i.e., soil, sediment, surface water, and groundwater) are based on the sampling results of the media, as described below.

Exposure from direct contact pathways represents exposure to media at the source, and the EPC is based on data collected at the source. Current measured concentrations of chemicals were used to represent future concentrations in the media of interest.

The EPCs developed for each COPC represent an UCL_{95} on the mean or the maximum detected value for all locations within the EU. If the UCL_{95} is greater than the MDC, then the default EPC is the MDC for that constituent. EPCs were calculated using EPA guidance, *Supplemental Guidance to RAGS: Calculating the Concentration Term* (EPA 1992a). The data were tested using the Shapiro-Wilk test to determine distribution, normal or lognormal, of the concentrations. The UCL_{95} on the mean was calculated using the normal distribution equation (see Equation 6-8) when the concentrations are normally distributed, when concentrations are not judged to be normally or lognormally distributed, when the dataset contains fewer than five detections, or when the frequency of detection is less than 50%. For these situations, the UCL_{95} on the mean is calculated using the following equation.

$$UCL_{95}(normal) = \bar{x}_n + \frac{(t)(s_x)}{\sqrt{n}}, \quad \textbf{(6-8)}$$

where

$\bar{x}_n$ = mean of the untransformed data,
t = student-t statistic,
s_x = standard deviation of the untransformed data,
n = number of sample results available.

For lognormally distributed concentrations, the UCL_{95} on the mean is calculated using the Equation 6-9:

$$UCL_{95}(log\ normal) = e\left[\overline{x_l} + 0.5(s_i^{\,2}) + \frac{(s_i)(H)}{\sqrt{n-1}}\right], \quad \textbf{(6-9)}$$

where

e = constant (base of the natural log, equal to 2.718),
$\bar{x}_l$ = mean of the transformed data [l = log (x)],
s_l = standard deviation of the transformed data,
H = H-statistic,
n = number of sample results available.

6.4 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is to provide the toxicity data to evaluate the potential for COPCs to cause adverse health effects in exposed individuals. Where possible, it provides an estimate of the relationship between the intake or dose of a COPC and the likelihood or severity of adverse health effects as a result of that exposure. Toxic effects have been evaluated extensively by EPA. This section provides the results of the EPA evaluation of the chemicals identified as COPCs at Load Line 3.

6.4.1 Toxicity Information and U.S. Environmental Protection Agency Guidance for Noncarcinogens

Noncarcinogenic effects are evaluated by comparing an exposure or intake/dose with a reference dose (RfD) or reference concentration (RfC). The RfD and RfCs are determined using available dose-response data for individual chemicals. Scientists determine the exposure concentration or intake/dose below which no adverse effects are seen and add a safety factor (from 10 to 1,000) to determine the RfD or RfC. RfDs and RfCs are identified by scientific committees supported by EPA. The RfDs available for the COPCs present in Load Line 3 media are listed in Table Q-8 (EPA 1997b, 2004). In this SHHRA, RfCs, measured in milligrams per cubic meter, were converted to RfDs expressed in units of milligrams per kilogram body weight per day by using the default adult inhalation rate and body weight [i.e., (RfC × 20 m^3/d)/70 kg = RfD] (EPA 1989c).

Chronic RfDs are developed for protection from long-term exposure to a chemical (from 7 years to a lifetime); subchronic RfDs are used to evaluate short-term exposure (from 2 weeks to 7 years) (EPA 1989c). Since the potential receptors at Load Line 3 are not considered to have short-term exposures, a conservative approach has been taken for this SHHRA by using only chronic RfDs [chronic

RfDs generally result in HQs that are at least as large as (sometimes larger than) HQs calculated from subchronic RfDs].

Toxic effects are diverse and measured in various target body organs (e.g., they range from eye irritation to kidney or liver damage). EPA is currently reviewing methods for accounting for the difference in severity of effects; however, existing RfDs do not address this issue.

6.4.2 Toxicity Information and U.S. Environmental Protection Agency Guidance for Carcinogens

For carcinogens, risks are estimated as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as excess or incremental lifetime cancer risk (ILCR), which is cancer occurrence in addition to normally expected rates of cancer development. Excess cancer risk is estimated using a cancer slope factor (CSF). The CSF is defined as a plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime (EPA 1989c).

EPA expresses inhalation cancer potency as the unit risk based on the chemical concentration in air [i.e., risk per microgram (μg) of chemical per cubic meter (m^3) of ambient air]. These unit risks were converted to CSFs expressed in units of risk per mg of chemical per kg body weight per day by using the default adult inhalation rate and body weight [i.e., (Unit Risk × 70 kg × 1,000 μg/mg)/20 m^3/d].

CSFs used in the evaluation of risk from carcinogenic COPCs are listed in Table Q-9 (EPA 1997b, 2004).

6.4.3 Estimated Toxicity Values for Dermal Exposure

Oral and inhalation RfDs and CSFs are currently available. Dermal RfDs and CSFs were estimated from oral toxicity values using chemical-specific gastrointestinal absorption factors (GAFs) to calculate total absorbed dose. This conversion is necessary because most oral RfDs and CSFs are expressed as the amount of chemical administered per time and body weight; however, dermal exposure is expressed as an absorbed dose. Dermal toxicity factors are calculated from oral toxicity factors, as shown below (EPA 1992b):

$$RfD_{dermal} = RfD_{oral} \times GAF$$

$$CSF_{dermal} = CSF_{oral}/GAF$$

Per the FWHHRAM (USACE 2004), dermal CSFs and RfDs are estimated from the oral toxicity values using chemical-specific GAFs to calculate the total absorbed dose only for chemicals with GAF values < 0.5. Chemical-specific GAF values available from EPA's *Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (EPA 2002b) are used whenever possible. Not all COPCs have specific GAF values. When quantitative data are insufficient, a default GAF is used. A default value of 1.0 for organic and inorganic chemicals is used (EPA 2002b). The GAF and resulting dermal toxicity values used in this SHHRA are listed in Tables Q-8 and Q-9.

6.4.4 Assumptions Used in the Toxicity Assessment

Assumptions made in assigning toxicity values for COPCs at Load Line 3 are listed below.

- Thallium, as a metal, is evaluated using the toxicity values for thallium carbonate. This is the form of thallium with the most conservative toxicity values.

- Total chromium is evaluated using the toxicity values for Chromium III. This is the form of chromium, other than Chromium VI (which is evaluated as a separate COPC), with the most conservative toxicity values.

- Toxicity equivalency factors (TEFs) are applied to carcinogenic polycyclic aromatic hydrocarbons (cPAHs). The following TEFs are used to convert the cPAHs identified as COPCs at Load Line 3 to an equivalent concentration of benzo(*a*)pyrene.

cPAH	TEF
Benzo(*a*)pyrene	1
Benz(*a*)anthracene	0.1
Benzo(*b*)fluoranthene	0.1
Benzo(*k*)fluoranthene	0.01
Chrysene	0.001
Dibenzo(*a,h*)anthracene	1
Indeno(1,2,3-*cd*)pyrene	0.1

6.4.5 Chemicals without U.S. Environmental Protection Agency Toxicity Values

No RfDs or CSFs are available for some detected chemicals at Load Line 3 because the noncarcinogenic and/or carcinogenic effects of these chemicals have not yet been determined. Although these chemicals may contribute to health effects from exposure to contaminated media at Load Line 3, their effects cannot be quantified at the present time. As seen from Table 6-1, COPCs falling into this category for Load Line 3 include three explosives (2-amino-4,6-DNT, 4-amino-2,6-DNT, and nitrocellulose), two PAHs [benzo(*g,h,i*)perylene and phenanthrene], and one SVOC (acenaphthylene).

Previously withdrawn or provisional toxicity values are used for one COPC at Load Line 3: benzo(*a*)pyrene uses a provisional inhalation CSF. Without this provisional value, the inhalation pathway could not be quantitatively evaluated for this chemical.

No RfDs or CSFs are available for lead. EPA (1999) recommends the use of the Interim Adult Lead Methodology to support its goal of limiting risk of elevated fetal blood lead concentrations due to lead exposures to women of child-bearing age. This model is used to estimate the probability that the fetal blood lead level will exceed 10 μg/dL as a result of maternal exposure. This model is not appropriate for exposure frequencies less than 1 d/week because the first order elimination half-life of lead of approximately 30 d requires a constant lead intake over a duration of 90 days to reach quasi-steady state. Shorter exposures are expected to produce oscillations in blood lead concentrations due to absorption and subsequent clearance of lead between each exposure event (EPA 2003). Because of this limitation, lead exposures are evaluated for the Security Guard/Maintenance Worker and Resident Subsistence Farmer only. Complete documentation of the model is available at http://www.epa.gov/superfund/programs/lead/prods.htm. The model-supplied default values were used for all parameters, with the exception of the site-specific media concentration and exposure frequency. Input parameters and results of this model are provided in Tables Q-22 through Q-28.

The Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children (available at http://www.epa.gov/superfund/programs/lead/ieubk.htm) was used to evaluate the On-Site Resident Farmer child. The IEUBK model is used to predict the risk of elevated blood lead levels in children (under the age of seven) that are exposed to environmental lead from many sources. The model also predicts the risk (e.g., probability) that a typical child, exposed to specified media lead concentrations, will have a blood lead level greater or equal to the level associated with adverse health effects (10 μg/dL). Results of this model are provided in Tables Q-22 through Q-28.

6.5 RISK CHARACTERIZATION

Risk characterization for this SHHRA consists of (1) development of screening RGOs for Load Line 3 COPCs, (2) comparison of EPCs versus screening RGOs for Load Line 3 COPCs to determine Load Line 3 COCs, and (3) development of risk-based RGOs for use in the FS for Load Line 3 COCs.

This section is divided into three sections: methodology (Section 6.5.1), results of COC selection (Section 6.5.2), and risk-based RGOs for COCs (Section 6.5.3).

6.5.1 Methodology for Identifying Chemicals of Concern

The four-step process for identifying COCs for Load Line 3 is illustrated in Figure 6-1. Each of these steps is described below.

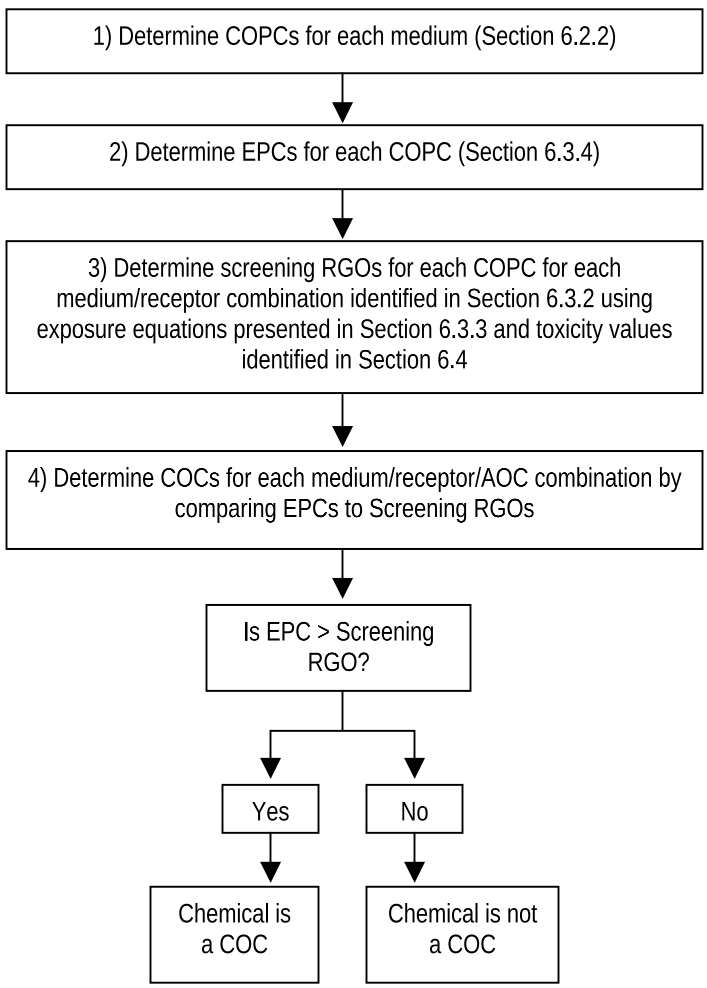

Figure 6-1. Human Health COC Determination Method for Load Line 3

6.5.2 Step 1 – Determine Chemicals of Potential Concern for Each Medium

Four environmental media were evaluated at Load Line 3: soil, surface water, sediment, and groundwater. Soil data are further aggregated by depth interval—shallow surface soils from 0 to 1 ft bgs, deep surface soils from 0 to 4 ft bgs, and subsurface soil greater than 1 ft bgs. Load Line 3 COPCs were identified for each exposure medium as described in Section 6.2; see also Table 6-1.

6.5.2.1 Step 2 – Determine EPCs for each COPC

EPCs were developed for each Load Line 3 COPC in each exposure medium as described in Section 6.3.4; see also Tables Q-1 to Q-6.

6.5.2.2 Step 3 – Determine screening RGOs for each COPC for each medium/receptor combination

Screening RGO are conservative RBCs used to identify COCs for Load Line 3. These screening RGOs may be more conservative than the risk-based RGOs calculated for this AOC (for the FS) because they are designed to identify all possible COCs at the site. Risk-based RGOs for the FS may take into account the number of COCs present.

Cancer risk is expressed as the probability that an individual will develop cancer over a lifetime as a result of exposure to the carcinogen. Cancer risk from exposure to contamination is expressed as the ILCR, or the increased chance of cancer above the normal background rate of cancer. In the United States, the background chance of contracting cancer is a little more than 3 in 10, or 3×10^{-1} (American Cancer Society 2003). The National Oil and Hazardous Substances Pollution Contingency Plan identifies a risk range of 10^{-6} to 10^{-4}, or 1-in-1 million to 1-in-10,000 exposed persons developing cancer (EPA 1990b) for remediation of contaminated sites. ILCRs below 10^{-6} are considered acceptable; ILCRs above 10^{-4} are considered unacceptable. The range between 10^{-6} and 10^{-4} is of concern, and any decisions to address ILCRs further in this range, either through additional study or engineered control measures, should account for the uncertainty in the risk estimates.

The formula for calculating ILCR is shown below (EPA 1989c):

$$ILCR = I \times CSF \qquad \textbf{(6-10)}$$

where

I = Intake (mg/kg-d) and $I = C \times E$ (as shown in Equation 6-1),
C = Exposure concentration in an environmental medium (mg/kg or mg/L),
E = Exposure as calculated using the exposure equations shown in Section 6.3.3 (d^{-1} or L/kg-d),
CSF = Cancer slope factor $(mg/kg\text{-}d)^{-1}$ (Table Q-9).

To calculate an RGO at a specific risk level (e.g., 10^{-6}), the above risk equation is rearranged so that the equation is solved for C, the concentration term as shown in Equation 6-11 for carcinogens.

$$\text{RGO at ILCR of } 10^{-6} = \frac{10^{-6}}{E \times CSF}, \qquad \textbf{(6-11)}$$

where

RGO = Remedial goal option (mg/kg or mg/L),
E = Exposure as calculated using the exposure equations shown in Section 6.3.3 (d^{-1} or L/kg-d),
CSF = Cancer slope factor $(mg/kg\text{-}d)^{-1}$ (Table Q-9).

Thus, to obtain the ingestion of soil RGO at the 10^{-6} risk level for the National Guard Trainee receptor exposed to arsenic, the parameter values for the National Guard Trainee receptor (from Table 6-3) and the chemical-specific parameter (oral CSF, from Table Q-9) for arsenic are used to calculate an RGO for soil ingestion of 12.2 mg/kg, which will produce a soil ingestion risk of 10^{-6} for the National Guard Trainee receptor exposed to arsenic. RGOs are calculated for each exposure pathway and for total exposure by all pathways for each medium.

Noncarcinogenic hazards associated with toxic (i.e., noncarcinogenic) effects are evaluated by comparing an estimated intake or dose from site media to an acceptable exposure expressed as an RfD. The RfD is the threshold level below which no toxic effects are expected to occur in a population, including sensitive subpopulations. The ratio of intake over the RfD is the HQ (EPA 1989c) and is calculated as:

$$HQ = I/RfD \qquad \textbf{(6-12)}$$

where

I = Intake (mg/kg-d) and I = C × E (as shown in Equation 6-1),
C = Exposure concentration in an environmental medium (mg/kg or mg/L),
E = Exposure (d^{-1} or L/kg-d) as calculated using the exposure equations shown in Section 6.3.3,
RfD = Reference dose (mg/kg-d) (Table Q-8).

HQs may be summed to obtain a hazard index (HI) for all chemicals present at a site. An HI greater than 1 has been defined as the level of concern for potential adverse noncarcinogenic health effects (EPA 1989c). This approach differs from the probabilistic approach used to evaluate carcinogens. An HQ of 0.01 does not imply a 1-in-100 chance of an adverse effect but indicates only that the estimated intake is 100 times less than the threshold level at which adverse health effects may occur.

To calculate an RGO at a specific hazard level (e.g., 0.1), the above hazard equation is rearranged so that the equation is solved for C, the concentration term, as shown in Equation 6-13 for noncarcinogens.

$$\text{RGO at HQ of 0.1} = \frac{0.1 \times RfD}{E}, \qquad \textbf{(6-13)}$$

where

RGO = Remedial goal option (mg/kg or mg/L),
RfD = Reference dose (mg/kg-d) (Table Q-8),
E = Exposure as calculated using the exposure equations shown in Section 6.3.3 (d^{-1} or L/kg-d).

The FWHHRAM (USACE 2004) identifies cumulative goals of 1×10^{-5} for cancer risk and 1.0 for non-cancer hazards for Load Line 3. To ensure that these goals for cumulative risk and hazard are met, a chemical-specific cancer risk goal of 1×10^{-6} was chosen to estimate screening RGOs; this risk level will ensure that any chemicals with risk > 1×10^{-6} are COCs and will provide for meeting the cumulative risk goal of 1×10^{-5} for Load Line 3 if multiple COCs are present. Likewise, a conservative chemical-specific hazard level of 0.1 was chosen to estimate screening RGOs; this hazard level will provide for meeting the cumulative hazard goal of 1.0 for Load Line 3 if multiple COCs are present.

For this SHHRA, screening RGOs are calculated for each exposure route (e.g., ingestion), as well as for the total chemical risk or hazard across all appropriate exposure routes. Note that if a calculated RGO is not physically possible (e.g., more than the pure chemical), then the RGO is adjusted accordingly. For example, if the calculated RGO is 5.5E+06 mg/kg, then the RGO is adjusted downward to 1.0E+06 mg/kg.

As described previously, COPCs were identified for groundwater, surface water, sediment, surface soil (shallow and deep), and subsurface soil. Screening RGOs are calculated for all COPCs in this SHHRA, for each appropriate receptor/medium combination evaluated. For COPCs with both cancer and non-cancer effects, the smallest RGO between the carcinogenic RGO (across all pathways) and the noncarcinogenic RGO (across all pathways) is chosen as the screening RGO; this is done for each COPC for each receptor/medium combination. The resulting screening RGOs are shown in Tables Q-10 to Q-15 for groundwater, surface water, sediment, shallow surface soil, deep surface soil, and subsurface soil, respectively.

6.5.2.3 Step 4 – Determine COCs for each medium/receptor combination

The method used in this SHHRA to determine human health COCs is to compare the EPCs (see Step 2 in Section 6.5.1.2) with the screening RGOs (see Step 3 in Section 6.5.1.3), for each COPC for each receptor/medium combination. Any COPC whose EPC is larger than its screening RGO is a human health COC for that particular receptor/medium combination; COPCs whose EPCs are smaller than their screening RGOs are not human health COCs for that particular receptor/medium combination.

It is important to note and understand that although HQs and ILCRs are not quantified in this SHHRA, the process of comparing the EPCs to screening RGOs at specific risk and hazard levels for specific receptors is equivalent to determining if the specific risk and hazard levels have been exceeded. For example, if the EPC for arsenic in shallow surface soil exceeds the screening RGO based on a risk of 10^{-6} for the Resident Farmer Adult, then the total risk across the ingestion, inhalation, and dermal pathways for the Resident Farmer Adult exposed to arsenic will be greater than 10^{-6}. Similarly, if the EPC for aluminum in shallow surface soil exceeds the screening RGO based on a hazard of 0.1 for the Resident Farmer Child, then the total hazard across the ingestion, inhalation, and dermal pathways for the Resident Farmer Child exposed to aluminum will be greater than 0.1. This comparison method allows one to categorize exposures to COPCs as being above or below the 10^{-6} risk level or 0.1 hazard level; chemicals that exceed these risk or hazard levels are deemed COCs in this SHHRA.

6.5.3 Risk Characterization Results

COCs are identified as COPCs whose EPC exceeds the screening RGO at a risk level of 10^{-6} or HQ of 0.1, whichever is smaller. COCs for Load Line 3 are identified in the following sections by EU and exposure medium. A summary of these results is presented for each medium/receptor/AOC combination in Table 6-4.

Table 6-4. Receptor/Medium/Exposure Unit Combinations with COCs at Load Line 3

COC	Groundwater			Surface Water					Sediment				
	National Guard Trainee	Resident Farmer Adult	Resident Farmer Child	Dust/Fire Control Worker	National Guard Trainee	Hunter/ Trapper/ Fisher	Resident Farmer Adult	Resident Farmer Child	Dust/Fire Control Worker	National Guard Trainee	Hunter/ Trapper/ Fisher	Resident Farmer Adult	Resident Farmer Child
Inorganics													
Aluminum													
Antimony													CP
Arsenic							CP	CP					
Barium													
Cadmium													
Manganese		LL3	LL3		CP		CP	CP					
Thallium													
Organic Explosives													
1,3-Dinitrobenzene													
2,4,6-Trinitrotoluene	LL3	LL3	LL3										
2,4-Dinitrotoluene													
RDX		LL3	LL3										
Organic PCBs													
PCB-1254													CP
PCB-1260													
Organic Pesticides													
4,4'-DDE													
Dieldrin													
Heptachlor													
Heptachlor Epoxide		LL3	LL3										
beta-BHC		LL3											
Organic Semivolatiles													
Benz(*a*)anthracene													
Benzo(*a*)pyrene												CP	CP
Benzo(*b*)fluoranthene													
Dibenz(*a,h*)anthracene													
Indeno(1,2,3-*cd*)pyrene													
Organic Volatiles													
Carbon Tetrachloride		LL3											

Table 6-4. Receptor/Medium/Exposure Unit Combinations with COCs at Load Line 3 (continued)

COC	Shallow Surface Soil					Deep Surface Soil	Subsurface Soil	
	Security Guard/ Maintenance Worker	Dust/Fire Control Worker	Hunter/ Trapper/ Fisher	Resident Farmer Adult	Resident Farmer Child	National Guard Trainee	Resident Farmer Adult	Resident Farmer Child
Inorganics								
Aluminum					CH,EH,PS	CH,EH,PS		
Antimony				DL,WD	DL,EH,PR,PS,WD			
Arsenic	DL,EH,PA,PR,PS,WD			DL,EH,PA,PR,PS,WD	DL,EH,PA,PR,PS,WD	DL,EH,PA,PR,PS,WD	EH,PA,PR	EH,PA,PR
Barium					PS	PS		
Cadmium					PA,PS	PA,PS		PA
Manganese				PS	CH,DL,EH,PA,PR,PS,WD	CH,DL,EH,PA,PR,PS,WD		
Thallium					PR			
Organic Explosives								
1,3-Dinitrobenzene	EH			EH	EH			
2,4,6-Trinitrotoluene	EH,PS,WD	EH,PS	EH	EH,PS,WD	EH,PS,WD	EH,PA,PS	EH,PA	EH,PA
2,4-Dinitrotoluene	EH			EH,PS	EH,PS			
RDX	EH,PA			EH,PA,PR	EH,PA,PR		PA	PA
Organic PCBs								
PCB-1254	CH,EH,PA,PR,PS,WD	EH,PA,PS	EH,PA,PS	CH,EH,PA,PR,PS,WD	CH,EH,PA,PR,PS,WD	CH,EH,PA,PR,PS,WD	EH	EH
PCB-1260	EH			EH,PR	EH			
Organic Pesticides								
4,4'-DDE				PA	PA			
Dieldrin	EH			EH,WD	EH,WD			
Heptachlor				PA	PA			
Heptachlor Epoxide								
beta-BHC								
Organic Semivolatiles								
Benz(*a*)anthracene	EH,WD			EH,PA,WD	EH,WD			
Benzo(*a*)pyrene	EH,PA,PR,PS,WD	WD		EH,PA,PR,PS,WD	EH,PA,PR,PS,WD	EH,WD		
Benzo(*b*)fluoranthene	EH,WD			EH,PA,WD	EH,PA,WD			
Dibenz(*a,h*)anthracene	EH,WD			EH,PA,PR,WD	EH,WD			
Indeno(1,2,3-*cd*)pyrene	EH,WD			EH,WD	EH,WD			
Organic Volatiles								
Carbon Tetrachloride								

Table 6-4. Receptor/Medium/Exposure Unit Combinations with COCs at Load Line 3 (continued)

COCs are shown for each medium/receptor/area of concern combination. Chemicals whose exposure point concentration exceeds its screening risk-based RGO are COCs. Area of concern codes are as follows:

LL3 = Load Line 3.
CH = Change Houses Aggregate.
CP = Cobb's Pond Tributary Aggregate.
DL = DLA Tanks Aggregate.
EH = Explosives Handling Areas Aggregate.
PA = Perimeter Area Aggregate.
PR = Preparation and Receiving Areas. Aggregate
PS = Packaging and Shipping Areas Aggregate.
WD = West Ditches Aggregate.

BHC = Benzene hexachloride.
COC = Chemical of concern.
DDE = Dichlorodiphenyldichloroethylene.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RGO = Remedial goal option. Screening risk-based RGOs are based on a cancer risk level of 10^{-6} or a hazard level of 0.1 (whichever is smaller) and are shown in Tables Q-10 through Q-15. Screening of Load Line 3 data to determine COCs is shown in Tables Q-16 through Q-21.

6.5.3.1 Groundwater

Eight COPCs were identified for the single groundwater aggregate at Load Line 3 (see Table Q-1); six of these eight COPCs have approved toxicity values and, thus, were determined to be quantitative COPCs (see Table 6-1). Screening RGOs were developed for these six groundwater COPCs, for the three receptors (National Guard Trainee, Resident Farmer Adult, and Resident Farmer Child) exposed to groundwater in this SHHRA (see Table Q-10). Table Q-16 shows the actual screening to determine groundwater COCs for these three receptors. A summary of the resulting COCs is shown in Table 6-4.

A total of six COCs were identified for the one groundwater aggregate, including: 2,4,6-TNT for all three receptors; manganese, RDX, and heptachlor epoxide for both the Resident Farmer Adult and Resident Farmer Child; and beta-BHC and carbon tetrachloride for the Resident Farmer Adult only. Risk-based RGOs were developed for these six COCs, for all three receptors exposed to groundwater (see Section 6.5.3).

6.5.3.2 Surface water

Two surface water COPCs were identified for the Cobb's Pond Aggregate (see Tables Q-2 and 6-1). Screening RGOs were developed for these two surface water COPCs, for the five receptors (National Guard Fire/Dust Suppression Worker, National Guard Trainee, Hunter/Trapper/Fisher, Resident Farmer Adult, and Resident Farmer Child) exposed to surface water in this SHHRA (see Table Q-11). Table Q-17 shows the actual screening to determine surface water COCs for these five receptors. A summary of the resulting COCs is shown in Table 6-4.

Both surface water COPCs were identified as COCs at the Cobb's Pond Aggregate: arsenic for the Resident Farmer Adult and Resident Farmer Child only; and manganese for the National Guard Trainee, Resident Farmer Adult, and Resident Farmer Child. Risk-based RGOs were developed for these two COC, for all five receptors exposed to surface water (see Section 6.5.3).

6.5.3.3 Sediment

Six sediment COPCs were identified for the Cobb's Pond Aggregate (see Table Q-3). Three of the six sediment COPCs have approved toxicity values and, thus, were determined to be quantitative COPCs (see Table 6-1). Screening RGOs were developed for these three sediment quantitative COPCs, for the five receptors (National Guard Fire/Dust Suppression Worker, National Guard Trainee, Hunter/Trapper/Fisher, Resident Farmer Adult, and Resident Farmer Child) exposed to sediment in this SHHRA (see Table Q-12). Table Q-18 shows the actual screening to determine sediment COCs for these five receptors. A summary of the resulting COCs is shown in Table 6-4.

All three sediment COPCs were identified as COCs for the Cobb's Pond Aggregate: antimony and PCB-1254 were identified as COCs for the Resident Farmer Child only; and benzo(*a*)pyrene was identified as a COC for both the Resident Farmer Adult and Resident Farmer Child. Risk-based RGOs were developed for these three COC, for all five receptors exposed to sediment (see Section 6.5.3).

6.5.3.4 Shallow surface soil

Shallow surface soil is defined by the following seven aggregates:

- Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10),
- Preparation and Receiving Areas Aggregate (Buildings EB-3 and EB-803),
- Packaging and Shipping Areas Aggregate (Buildings EB-11, EB-13A/-13B),
- Change Houses Aggregate,

- DLA Storage Tanks Aggregate,
- West Ditches Aggregate, and
- Perimeter Area Aggregate.

A total of 35 shallow surface soil COPCs were identified within the seven soil aggregates (see Table Q-4). Twenty-eight of these 35 shallow surface soil COPCs have approved toxicity values and, thus, were determined to be quantitative COPCs (see Table 6-1). Lead was also a shallow surface soil COPC in six of the seven soil aggregates (all except for the Change Houses Aggregate); lead is discussed separately below.

Screening RGOs were developed for the 28 shallow surface soil quantitative COPCs, for the five receptors (National Guard Security Guard/Maintenance Worker, National Guard Fire/Dust Suppression Worker, Hunter/Trapper/Fisher, Resident Farmer Adult, and Resident Farmer Child) exposed to shallow surface soil in this SHHRA (see Table Q-13). Table Q-19 shows the actual screening to determine shallow surface soil COCs for these five receptors. A summary of these COCs is shown in Table 6-4; results are discussed below for each aggregate.

Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10)

Sixteen shallow surface soil COCs were identified for the Explosives Handling Areas. These COCs included the following.

- 4 metals: aluminum, antimony, and manganese, all for the Resident Farmer Child only; and arsenic, for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;

- 4 explosives: 1,3-DNB; 2,4,6-TNT; 2,4-DNT; and RDX, all for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child; 2,4,6-TNT was a COC for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher as well;

- 2 PCBs: PCB-1254 and PCB-1260, both for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child; PCB-1254 was a COC for the Fire/Dust Suppression Worker and Hunter/Trapper/Fisher as well;

- 1 pesticide: dieldrin was identified as a COC for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child; and

- 5 PAHs: benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(*1,2,3-cd*)pyrene, all for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child.

Preparation and Receiving Areas Aggregate (Buildings EB-3, DB-803)

Eight shallow surface soil COCs were identified for the Preparation and Receiving Areas Aggregate. These COCs included the following.

- 4 metals: antimony, manganese, and thallium, all for the Resident Farmer Child only; and arsenic, for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;

- 1 explosive: RDX, a COC for the Resident Farmer Adult and Resident Farmer Child;

- 2 PCBs: PCB-1254, for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child; and PCB-1260, for the Resident Farmer Adult only; and

- 1 PAH: benzo(*a*)pyrene, a COC for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child.

Packaging and Shipping Areas Aggregate (Buildings EB-11, EB-13A/-13B)

Ten shallow surface soil COCs were identified for the Packaging and Shipping Areas Aggregate. These COCs included the following.

- 6 metals: aluminum, antimony, barium, and cadmium, all for the Resident Farmer Child only; manganese, for the Resident Farmer Adult and Resident Farmer Child; and arsenic, for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;

- 2 explosives: 2,4,6-TNT, for the Security Guard/Maintenance Worker, Fire/Dust Suppression Worker, Resident Farmer Adult, and Resident Farmer Child; and 2,4-DNT, for the Resident Farmer Adult and Resident Farmer Child;

- 1 PCB: PCB-1254, for all five shallow surface soil receptors (Security Guard/Maintenance Worker, Fire/Dust Suppression Worker, Hunter/Trapper/Fisher, Resident Farmer Adult, and Resident Farmer Child); and

- 1 PAH: benzo(*a*)pyrene, a COC for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child.

Change Houses Aggregate

Three shallow surface soil COCs were identified for the Change Houses Aggregate. These COCs included the following.

- 2 metals: aluminum and manganese, both for the Resident Farmer Child only; and

- 1 PCB: PCB-1254, for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child).

DLA Storage Tanks Aggregate

Three metals were identified as shallow surface soil COCs for the DLA Storage Tanks Aggregate. These COCs included manganese for the Resident Farmer Child only; antimony for the Resident Farmer Adult and Resident Farmer Child; and arsenic for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child.

West Ditches Aggregate

Eleven shallow surface soil COCs were identified for the West Ditches Aggregate. These COCs included the following.

- 3 metals: manganese for the Resident Farmer Child only; antimony, for the Resident Farmer Adult and Resident Farmer Child; and arsenic, for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;

- 1 explosive: 2,4,6-TNT, a COC for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;

- 1 PCB: PCB-1254, a COC for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;
- 1 pesticide: dieldrin, a COC for the Resident Farmer Adult and Resident Farmer Child; and
- 5 PAHs: benz(*a*)anthracene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene, all for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child; and benzo(*a*)pyrene, a COC for the Security Guard/Maintenance Worker, Fire/Dust Suppression Worker, Resident Farmer Adult, and Resident Farmer Child.

Perimeter Area Aggregate

Eleven shallow surface soil COCs were identified for the Perimeter Area Aggregate. These COCs included the following.

- 3 metals: cadmium and manganese, both for the Resident Farmer Child only; and arsenic, for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;
- 1 explosive: RDX, a COC for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child;
- 1 PCB: PCB-1254, a COC for all five shallow surface soil receptors (Security Guard/Maintenance Worker, Fire/Dust Suppression Worker, Hunter/Trapper/Fisher, Resident Farmer Adult, and Resident Farmer Child);
- 2 pesticides: 4,4'-DDE and heptachlor, both COCs for the Resident Farmer Adult and Resident Farmer Child); and
- 4 PAHs: benz(*a*)anthracene, dibenz(*a,h*)anthracene, both for the Resident Farmer Adult; benzo(*b*)fluoranthene, for the Resident Farmer Adult and Resident Farmer Child; and benzo(*a*)pyrene, a COC for the Security Guard/Maintenance Worker, Resident Farmer Adult, and Resident Farmer Child.

Across all seven aggregates, a total of 21 COCs were identified for shallow surface soil (7 metals, 4 explosives, 2 PCBs, 3 pesticides, and 5 PAHs); see Table 6-4. Risk-based RGOs were developed for all 21 of these COCs, for all five receptors exposed to this medium (see Section 6.5.3).

Evaluation of Lead in Shallow Surface Soil

Lead was identified as a COPC in shallow surface soil at the following EUs: Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10), Preparation and Receiving Areas Aggregate (Buildings EB-3 and EB-803), Packaging and Shipping Areas Aggregate (Buildings EB-11, EB-13A/13B), DLA Storage Tanks Aggregate, West Ditches Aggregate, and Perimeter Area Aggregate.

Two adult receptors were evaluated for exposure to lead in the shallow surface soil using the adult lead model: the Security Guard/Maintenance Worker and Resident Farmer Adult (all other receptors had exposure frequencies too short to be evaluated with the adult lead model). The estimated probability of fetal blood lead concentrations exceeding acceptable levels was less than 5% at the DLA Storage Tanks Aggregate (Table Q-22); less than 3% at the Explosives Handling Areas Aggregate (Table Q-23); less than 14% at the Packaging and Shipping Areas Aggregate (Table Q-24); less than 7% at the Perimeter Area (Table Q-25) and at the Preparation and Receiving Areas Aggregates (Table Q-26); and less than 3% at the West Ditches Aggregate (Table Q-27).

For the child receptor (Resident Farmer), the estimated probabilities of exceeding target blood lead levels were as follows: 22% at the DLA Storage Tanks Aggregate (Table Q-22); 6% at the Explosives Handling Areas Aggregate (Table Q-23); 67% at the Packaging and Shipping Areas Aggregate (Table Q-24); 37% at the Perimeter Area (Table Q-25) and at the Preparation and Receiving Areas Aggregates (Table Q-26); and 6% at the West Ditches Aggregate (Table Q-27).

Based on these results, lead may be considered a COC at the Packaging and Shipping Areas, DLA Storage Tanks, Perimeter Area, and Preparation and Receiving Areas Aggregates.

6.5.3.5 Deep surface soil

Deep surface soil is defined by the following seven aggregates:

- Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10),
- Preparation and Receiving Areas Aggregate (Buildings EB-3 and EB-803),
- Packaging and Shipping Areas Aggregate (Buildings EB-11, EB-13A/-13B),
- Change Houses Aggregate,
- DLA Storage Tanks Aggregate,
- West Ditches Aggregate, and
- Perimeter Area Aggregate.

A total of 35 deep surface soil COPCs were identified in the seven soil aggregates (see Table Q-5). Twenty-eight of these 35 deep surface soil COPCs have approved toxicity values and, thus, were determined to be quantitative COPCs (see Table 6-1). Lead was also a deep surface soil COPC in six of the seven aggregates (all except for the Change Houses Aggregate); however, because the exposure frequency for the National Guard Trainee (the only receptor with exposures to deep surface soils) is relatively short, the adult blood lead modeling was not appropriate.

Screening RGOs were developed for the 28 deep surface soil quantitative COPCs, for the one receptor (National Guard Trainee) exposed to deep surface soil in this SHHRA (see Table Q-14). Table Q-20 shows the actual screening to determine deep surface soil COCs for this receptor. A summary of these COCs is shown in Table 6-4; results are discussed below for each aggregate.

Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10)

Six deep surface soil COCs were identified for the Explosives Handling Areas. These COCs included the following.

- 3 metals: aluminum, arsenic, and manganese;
- 1 explosive: 2,4,6-TNT;
- 1 PCB: PCB-1254; and
- 1 PAH: benzo(*a*)pyrene.

Preparation and Receiving Areas Aggregate (Buildings EB-3, EB-803)

Three deep surface soil COCs were identified for the Preparation and Receiving Areas Aggregate. These COCs included the following.

- 2 metals: arsenic and manganese; and
- 1 PCB: PCB-1254.

Packaging and Shipping Areas Aggregate (Buildings EB-11 and EB-13A/-13B)

Seven deep surface soil COCs were identified for the Packaging and Shipping Areas Aggregate. These COCs included the following.

- 5 metals: aluminum, arsenic, barium, cadmium, and manganese;
- 1 explosive: 2,4,6-TNT; and
- 1 PCB: PCB-1254.

Change Houses Aggregate

Three deep surface soil COCs were identified for the Change Houses Aggregate. These COCs included two metals (aluminum and manganese) and one PCB (PCB-1254). These COCs included the following.

- 2 metals: aluminum and manganese; and
- 1 PCB: PCB-1254.

DLA Storage Tanks Aggregate

Two metals were identified as deep surface soil COCs for the DLA Tanks Aggregate: arsenic and manganese.

West Ditches Aggregate

Four deep surface soil COCs were identified for the West Ditches Aggregate. These COCs included the following.

- 2 metals: arsenic and manganese;
- 1 PCB: PCB-1254; and
- 1 PAH: benzo(*a*)pyrene.

Perimeter Area Aggregate

Five deep surface soil COCs were identified for the Perimeter Area Aggregate. These COCs included the following.

- 3 metals: arsenic, cadmium, and manganese;
- 1 explosive: 2,4,6-TNT; and
- 1 PCB: PCB-1254.

Across all seven aggregates, a total of eight COCs were identified for deep surface soil (five metals, one explosive, one PCB, and one PAH); see Table 6-4. Risk-based RGOs were developed for all eight of these COCs, for the National Guard Trainee exposed to this medium (see Section 6.5.3).

6.5.3.6 Subsurface soil

Subsurface soil is defined by the following three aggregates:

- Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10),
- Preparation and Receiving Areas Aggregate (Buildings EB-3 and EB-803), and
- Perimeter Area Aggregate.

A total of 10 subsurface soil COPCs were identified in three subsurface soil aggregates (see Table Q-6). Excluding lead, 7 of these 10 subsurface soil COPCs have approved toxicity values and, thus, were determined to be quantitative COPCs (see Table 6-1). Lead was also a subsurface soil COPC in the Perimeter Area Aggregate; lead is further discussed below.

Screening RGOs were developed for the seven subsurface soil quantitative COPCs, for the two receptors (Resident Farmer Adult and Resident Farmer Child) exposed to subsurface soil in this SHHRA (see Table Q-15). Table Q-21 shows the actual screening to determine subsurface soil COCs for these two receptors. A summary of the subsurface soil COCs is shown in Table 6-4; results are discussed below for each aggregate.

Explosives Handling Areas Aggregate (Buildings EB-4/-4A, EB-6/-6A, and EB-10)

Three subsurface soil COCs were identified for the Explosives Handling Areas. These COCs included the following.

- 1 metal: arsenic, for both the Resident Farmer Adult and Resident Farmer Child;
- 1 explosive: 2,4,6-TNT, for both the Resident Farmer Adult and Resident Farmer Child; and
- 1 PCB: PCB-1254, for both the Resident Farmer Adult and Resident Farmer Child.

Preparation and Receiving Areas Aggregate (Buildings EB-3 and EB-803)

One metal was identified as a subsurface soil COC at the Preparation and Receiving Areas Aggregate: arsenic, for both the Resident Farmer Adult and Child.

Perimeter Area Aggregate

Four subsurface soil COCs were identified for the Perimeter Area Aggregate. These COCs included the following.

- 2 metals: arsenic, for both the Resident Farmer Adult and Child; and cadmium, for the Resident Farmer Child only; and

- 2 explosives: 2,4,6-TNT and RDX, both for the Resident Farmer Adult and Child.

Across all three aggregates, a total of five COCs were identified for subsurface soil (two metals, two explosives, and one PCB); see Table 6-4. Risk-based RGOs were developed for all five of these COCs, for both receptors exposed to this medium (see Section 6.5.3).

Evaluation of Lead in Subsurface Soil

Lead was identified as a COPC in subsurface soil at the Perimeter Area Aggregate. Consequently, the Resident Farmer Adult was evaluated for exposure to lead in the Perimeter Area Aggregate subsurface soil using the EPA adult lead model. The estimated probability of fetal blood lead concentrations exceeding acceptable levels was 7 to 9% in this EU. Results of the child lead model (for the Resident Farmer Child) indicated that the estimated probability of exceeding target blood lead levels was 53% at the Perimeter Area Aggregate (Table Q-28).

Based on these results, lead may be considered a COC at the Perimeter Area Aggregate.

6.5.4 Remedial Goal Options for Chemicals of Concern

To support the remedial alternative selection process, RGOs were developed for each chemical identified as a COC in the direct exposure pathways for this Load Line 3 SHHRA. These RGOs are risk-based concentrations that will be used in the FS to assist in defining the extent of contamination to be remediated and, thus, will help cost various alternatives. RGOs are media- and chemical-specific concentrations and are calculated for COCs within each land use/receptor scenario for a given medium. The RGOs presented in this chapter are for protection of human health and may or may not be protective of ecological receptors. The process for calculating RGOs for this SHHRA is a rearrangement of the cancer risk or non-cancer hazard equations, with the goal of obtaining the concentration that will produce a specific risk or hazard level.

Section 6.5.1.3 presented the methods for determining RGOs. Section 6.5.1.3 indicated how to estimate RGOs at the 10^{-6} risk level and 0.1 hazard level; these levels were levels for screening the Load Line 3 data in order to determine COCs. In this section, different risk and hazard levels are used to determine risk-based RGOs for the COCs, but the methods detailed in Section 6.5.1.3 apply here as well.

The FWHHRAM (USACE 2004) identifies a 10^{-5} target excess individual lifetime cancer risk (TR) for carcinogens and an acceptable Target Hazard Index (THI) of 1 for noncarcinogens, with the caveat that exposure to multiple COCs may require downward adjustment of these targets. The TR and THI are dependent on several factors, including the number of carcinogenic and noncarcinogenic COCs and the target organs and toxic endpoints of these COCs.

For example, if numerous (i.e., approaching or greater than 10) noncarcinogenic COCs with similar toxic endpoints are present, it may be appropriate to calculate chemical-specific RGOs with a THI of 0.1 to account for exposure to multiple contaminants. A TR of 10^{-5} and THI of 1.0 are identified as appropriate for calculating RGOs for Load Line 3 based on the small number of COCs identified for each exposure medium as described below for the National Guard Trainee (the most likely receptor at Load Line 3)], and the type of COCs (carcinogenic or noncarcinogenic).

- Groundwater – Only 1 COC was identified for the National Guard Trainee. This COC (2,4,6-TNT) is a noncarcinogen.

- Surface water – Only 1 noncarcinogenic COC (manganese) was identified for the National Guard Trainee exposed to surface water.

- Sediment – No COCs were identified for the National Guard Trainee exposed to sediment. Only three COCs were identified for residential exposure to this medium.

- Surface soil – A total of eight COCs were identified for the National Guard Trainee: three carcinogens and five noncarcinogens. Of the three carcinogens, one (arsenic) is a class A carcinogen with the lungs or respiratory system as the target organ and two [PCB-1254 and benzo(*a*)pyrene] are class B2 carcinogens but with differing target organs (liver and larynx/stomach). The five noncarcinogens (aluminum; barium; cadmium; manganese; and 2,4,6-TNT) have differing toxic endpoints (not defined, blood, kidney, central nervous system, and liver respectively).

Risk-based RGOs for COCs in groundwater, surface water, sediment, surface soil, and subsurface soil are presented in Tables 6-5 through 6-10. These RGOs are provided here to assist in defining the extent of contamination and to help cost various alternatives in the FS. During the process of remedy selection for the

Table 6-5. Risk-based RGOs (mg/L) for Groundwater COCs at Load Line 3

COC	Total RGO[a] National Guard Trainee		Total RGO[a] Resident Farmer Adult		Total RGO[a] Resident Farmer Child	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}
Inorganics						
Manganese	1.4E+01	--	1.6E+00	--	4.6E-01	--
Organic Explosives						
2,4,6-Trinitrotoluene	1.6E-01	3.0E-01	1.8E-02	2.8E-02	5.2E-03	4.0E-02
RDX	9.8E-01	8.3E-02	1.1E-01	7.7E-03	3.1E-02	1.1E-02
Organic Pesticides						
Heptachlor Epoxide	4.0E-03	9.4E-04	4.4E-04	8.8E-05	1.3E-04	1.3E-04
beta-BHC	--	4.8E-03	--	4.4E-04	--	6.5E-04
Organic Volatiles						
Carbon Tetrachloride	2.2E-01	2.3E-02	2.4E-02	2.1E-03	7.1E-03	3.9E-03

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation).
BHC = Benzene hexachloride.
COC = Chemical of concern.
HQ = Hazard quotient.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RGO = Remedial goal option.
-- = No RGO could be quantified, based on lack of approved toxicity value.

Table 6-6. Risk-based RGOs (mg/L) for Surface Water COCs at Load Line 3

COC	Total RGO[a] Dust/Fire Control		Total RGO[a] National Guard Trainee		Total RGO[a] Hunter/ Trapper		Total RGO[a] Resident Farmer Adult		Total RGO[a] Resident Farmer Child	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}
Inorganics										
Arsenic	4.1E+00	2.5E-01	7.8E-01	4.8E-02	1.1E+01	5.9E-01	1.7E-01	8.9E-03	4.2E-02	1.1E-02
Manganese	1.5E+02	--	1.1E+01	--	2.1E+02	--	6.0E+00	--	2.6E+00	--

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation).
COC = Chemical of concern.
HQ = Hazard quotient.
RGO = Remedial goal option.
-- = No RGO could be quantified, based on lack of approved toxicity value.

Table 6-7. Risk-based RGOs (mg/kg) for Sediment COCs at Load Line 3

COC	Total RGO[a] Dust/Fire Control		Total RGO[a] National Guard Trainee		Total RGO[a] Hunter/ Trapper		Total RGO[a] Resident Farmer Adult		Total RGO[a] Resident Farmer Child	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}
Inorganics										
Antimony	2.9E+04	--	2.5E+03	--	5.0E+04	--	2.5E+02	--	3.1E+01	--
Organic PCBs										
PCB-1254	2.2E+02	1.5E+02	5.5E+01	3.5E+01	3.1E+02	1.8E+02	3.5E+00	2.0E+00	1.2E+00	3.5E+00
Organic Semivolatiles										
Benzo(*a*)pyrene	--	4.5E+01	--	1.0E+01	--	5.3E+01	--	5.9E-01	--	9.7E-01

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation).
COC = Chemical of concern.
HQ = Hazard quotient.
PCB = Polychlorinated biphenyl.
RGO = Remedial goal option.
-- = No RGO could be quantified, based on lack of approved toxicity value.

Table 6-8. Risk-based RGOs (mg/kg) for Shallow Surface Soil COCs at Load Line 3

COC	Total RGO[a] Security Guard/ Maintenance Worker		Total RGO[a] Dust/Fire Control		Total RGO[a] Hunter/ Trapper		Total RGO[a] Resident Farmer Adult		Total RGO[a] Resident Farmer Child	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}
Inorganics										
Aluminum	1.0E+06	--	1.0E+06	--	1.0E+06	--	7.0E+05	--	7.8E+04	--
Antimony	2.1E+03	--	2.9E+04	--	4.8E+04	--	2.5E+02	--	3.1E+01	--
Arsenic	4.2E+02	2.6E+01	1.1E+04	6.9E+02	1.6E+04	8.1E+02	1.3E+02	6.7E+00	2.2E+01	5.7E+00
Barium	1.9E+05	--	1.0E+06	--	1.0E+06	--	3.8E+04	--	5.3E+03	--
Cadmium	1.1E+03	1.0E+06	3.0E+04	1.0E+06	4.2E+04	1.0E+06	3.8E+02	7.3E+04	7.2E+01	1.6E+05
Manganese	7.5E+04	--	1.0E+06	--	1.0E+06	--	2.0E+04	--	3.3E+03	--
Thallium	1.3E+03	--	7.7E+03	--	1.4E+04	--	5.7E+01	--	6.2E+00	--
Organic Explosives										
1,3-Dinitrobenzene	4.3E+01	--	1.5E+03	--	1.9E+03	--	2.2E+01	--	6.4E+00	--
2,4,6-Trinitrotoluene	2.2E+02	4.1E+02	7.4E+03	1.4E+04	9.6E+03	1.5E+04	1.1E+02	1.7E+02	3.2E+01	2.5E+02
2,4-Dinitrotoluene	8.7E+02	1.8E+01	2.9E+04	6.1E+02	3.8E+04	6.6E+02	4.5E+02	7.6E+00	1.3E+02	1.1E+01
RDX	1.3E+03	1.1E+02	4.4E+04	3.7E+03	5.8E+04	4.1E+03	6.7E+02	4.7E+01	1.9E+02	6.8E+01
Organic PCBs										
PCB-1254	6.2E+00	4.4E+00	2.2E+02	1.5E+02	2.8E+02	1.6E+02	3.5E+00	2.0E+00	1.2E+00	3.5E+00
PCB-1260	--	4.4E+00	--	1.5E+02	--	1.6E+02	--	2.0E+00	--	3.5E+00
Organic Pesticides										
4,4'-DDE	--	3.6E+01	--	1.2E+03	--	1.3E+03	--	1.5E+01	--	2.2E+01
Dieldrin	2.2E+01	7.6E-01	7.4E+02	2.6E+01	9.6E+02	2.8E+01	1.1E+01	3.2E-01	3.2E+00	4.7E-01
Heptachlor	2.2E+02	2.7E+00	7.4E+03	9.2E+01	9.6E+03	1.0E+02	1.1E+02	1.2E+00	3.2E+01	1.7E+00
Organic Semivolatiles										
Benz(*a*)anthracene	--	1.3E+01	--	4.5E+02	--	4.8E+02	--	5.9E+00	--	9.7E+00
Benzo(*a*)pyrene	--	1.3E+00	--	4.5E+01	--	4.8E+01	--	5.9E-01	--	9.7E-01
Benzo(*b*)fluoranthene	--	1.3E+01	--	4.5E+02	--	4.8E+02	--	5.9E+00	--	9.7E+00
Dibenz(*a,h*)anthracene	--	1.3E+00	--	4.5E+01	--	4.8E+01	--	5.9E-01	--	9.7E-01
Indeno(1,2,3-*cd*)pyrene	--	1.3E+01	--	4.5E+02	--	4.8E+02	--	5.9E+00	--	9.7E+00

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation).
COC = Chemical of concern.
DDE = Dichlorodiphenyldichloroethylene.
HQ = Hazard quotient.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RGO = Remedial goal option.
-- = No RGO could be quantified, based on lack of approved toxicity value.

Table 6-9. Risk-based RGOs (mg/kg) for Deep Surface Soil COCs at Load Line 3

COC	Total RGO[a] National Guard Trainee	
	HQ = 1.0	Risk = 10^{-5}
Inorganics		
Aluminum	3.5E+04	--
Arsenic	1.5E+03	3.1E+01
Barium	3.5E+03	--
Cadmium	4.7E+03	1.1E+02
Manganese	3.5E+02	--
Organic Explosives		
2,4,6-Trinitrotoluene	1.6E+03	3.1E+03
Organic PCBs		
PCB-1254	5.5E+01	3.5E+01
Organic Semivolatiles		
Benzo(*a*)pyrene	--	1.0E+01

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation).
COC = Chemical of concern.
HQ = Hazard quotient.
PCB = Polychlorinated biphenyl.
RGO = Remedial goal option.
-- = No RGO could be quantified, based on lack of approved toxicity value.

Table 6-10. Risk-based RGOs (mg/kg) for Subsurface Soil COCs at Load Line 3

COC	Total RGO[a] Resident Farmer Adult		Total RGO[a] Resident Farmer Child	
	HQ = 1.0	Risk = 10^{-5}	HQ = 1.0	Risk = 10^{-5}
Inorganics				
Arsenic	1.3E+02	6.7E+00	2.2E+01	5.7E+00
Cadmium	3.8E+02	7.3E+04	7.2E+01	1.6E+05
Organic Explosives				
2,4,6-Trinitrotoluene	1.1E+02	1.7E+02	3.2E+01	2.5E+02
RDX	6.7E+02	4.7E+01	1.9E+02	6.8E+01
Organic PCBs				
PCB-1254	3.5E+00	2.0E+00	1.2E+00	3.5E+00

[a] Total RGO is the RGO across all pathways (ingestion, dermal, and inhalation).
COC = Chemical of concern.
HQ = Hazard quotient.
PCB = Polychlorinated biphenyl.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RGO = Remedial goal option.
-- = No RGO could be quantified, based on lack of approved toxicity value.

site, final RGOs may consider additional information, such as background concentrations, and will be identified to meet risk and hazard goals. The final RGOs may consider additional information, such as background concentrations, and will be reviewed by Ohio EPA prior to remedy selection.

6.6 UNCERTAINTY ANALYSIS

This section identifies the uncertainties associated with each step of the SHHRA process used for Load Line 3. Uncertainties are not cumulative and are not mutually exclusive.

6.6.1 Uncertainties Associated with the Data Evaluation

Although the data evaluation process used to select COPCs adheres to established procedures and guidance, it also requires making decisions and developing assumptions on the basis of historical information, disposal records, process knowledge, and best professional judgment about the data. Uncertainties are associated with all such assumptions. The background concentrations and PRGs used to screen analytes are also subject to uncertainty.

In addition, the determination of the chemical for certain analytes is subject to various assumptions. For example, it is assumed that all metallic thallium is present as the most toxic form (thallium carbonate).

Another area of uncertainty involves the qualitative evaluation (and elimination from further consideration) of essential nutrients, many of which have no available toxicity values. In addition, the toxicity values used in the derivation of PRGs are subject to change, as additional information becomes available from scientific research. These periodic changes in toxicity values may cause the PRG values to change as well.

Uncertainty can be introduced in the data aggregation process. Any changes to criteria governing how data are grouped affect the summary statistics. For example, if data from a single sample are removed from an aggregate, the MDC could change for that aggregate. This change could effect whether an MDC detected concentration is used in the PRG screening process). Other summary statistics could be affected as well.

Representative exposure concentrations are calculated in this SHHRA based on the assumption that the samples collected from each EU are truly random samples. In fact, only the samples collected from the perimeter EU were collected randomly. Sample locations for all other EUs were biased to identify areas of highest contaminant concentrations. Seasonal variations in the data may also exist (especially with the surface water and groundwater data), which may not have been captured in the calculation of the EPCs.

In addition, in the evaluation of the various media, environmental concentrations are assumed to be constant (i.e., concentrations are not reduced by loss due to natural removal processes such as volatilization, leaching, and/or biodegradation). Since the source of contamination (i.e., production and demilitarization of munitions) no longer exists at Load Line 3, this assumption is a source of uncertainty.

Water data from intermittent ditches have not been quantitatively evaluated in this SHHRA. One water sample from intermittent ditches was available, but these data were not evaluated because water is rarely available for exposure to potential receptors; therefore, the associated risk is expected to be very small.

Some unavoidable uncertainty is associated with the contaminant concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the risk assessment depends on the adequacy of the set of procedures that specifies how samples are selected and handled and how strictly these procedures are followed. QA/QC procedures within the laboratories are used to minimize uncertainties; however, sampling errors, laboratory analysis errors, and data analysis errors can occur.

Some current analytical methods are limited in their ability to achieve detection limits at or below risk-based screening levels (i.e., PRG concentrations). Under these circumstances, it is uncertain whether the true concentration is above or below the PRGs, which are protective of human health. When analytes are on the COPC list and have a mixture of detected and non-detected concentrations, the determination of the EPC, and, ultimately, whether the chemical is a COC or not, may be affected by these detection limits. The number of COCs may be overestimated as a result of some sample concentrations being reported as non-detected at the MDL, which may be greater than the PRG concentration (when the actual concentration may be much smaller than the MDL). The number of COCs may also be underestimated because some analytes that are not detected in any sample are removed from the COPC list. If the concentrations of these analytes are below the MDL but are above the PRG, the chemicals are not included in the risk screening results.

The selection of COPCs in this SHHRA relied primarily on analyte concentrations obtained as the result of field sampling for the RI. The sources of COPCs are addressed in the selection of contaminants in exposure media for current environmental conditions. However, under future land use conditions, other contaminants not currently accounted for, particularly those that have slow transport velocities, may appear in secondary media at concentrations that could contribute to the calculated risk.

6.6.2 Uncertainties Associated with the Exposure Assessment

Moderate uncertainty can be introduced in the data aggregation process for estimating a representative exposure concentration in the exposure media. A statistical test (the Shapiro-Wilk test) is performed to determine whether the concentration data are best described by a normal or lognormal distribution. Each COPC's mean and UCL_{95} on the mean concentrations are calculated using both detected values and one-half of the reported detection limit for samples without a detected concentration. The EPC is the smaller of the MDC or the calculated UCL_{95}. This method may moderately overestimate the exposure concentration.

As described previously, some uncertainty is associated with the contaminant concentrations detected and reported by the analytical laboratory. The quality of the analytical data used in the risk assessment depends on the adequacy of the set of procedures that specifies how samples are to be selected and handled and how strictly these procedures are followed. QA/QC procedures are used to minimize uncertainties; however, sampling errors, laboratory analysis errors, and data analysis errors can and do occur. Moreover, some current analytical methods are limited in their ability to achieve detection limits appropriate for use in risk assessment. Therefore, EPCs, and, ultimately, the number of COCs, may be overestimated as a result of analyte concentrations being reported at the MDL, which may be greater than the concentration at which adverse health effects could occur. Additional uncertainties are introduced by detection limits that differ among the various s; these uncertainties are especially noticeable in the historical (i.e., Phase I) s. In addition, EPCs (and, ultimately, the number of COCs) may be underestimated if chemical concentrations are above risk criteria but below detection limits and reported as non-detects.

At best, quantification of exposure provides an estimate of the chemical intake for various exposure pathways identified at the site. Several uncertainties associated with the various components of the exposure assessment include uncertainties about the exposure pathway equations, exposure parameters, land use scenarios, representative exposure concentrations, and sampling and analysis of the media.

For each primary exposure pathway chosen for inclusion in the RGO calculation for this SHHRA, assumptions are made concerning the exposure parameters (e.g., amount of contaminated media a receptor can be exposed to and intake rates for different routes of exposure) and the routes of exposure. In the absence of site-specific data, the assumptions used are taken from the FWHHRAM (USACE 2004) and are consistent with EPA-approved default values, which are assumed to be representative of potentially exposed populations (EPA 1989c, 1991a). All contaminant exposures are assumed to be from site-related exposure media (i.e., no other sources contribute to the receptor's health risk).

Note that for the dermal contact with soil and sediment pathway, no exposure time is included in the equation. This is based on the assumption that the receptor may not bathe (i.e., remove the soil in contact with the skin surface) for 24 hr following the initial exposure; therefore, the receptor is actually exposed to soil contaminants for 24 hr/d. This may overestimate the exposure associated with dermal contact with soil or sediment. This fact is especially important when the dermal pathway is the major contributor to the RGO concentration used for determining COCs.

Most exposure parameters have been selected so that errors occur on the side of conservatism. When several of these upper-bound values are combined in estimating exposure for any one pathway, the resulting exposures can be in excess of the 99th percentile and, therefore, outside of the range that may be reasonably expected. Therefore, the consistent conservatism employed in the estimation of these parameters generally leads to overestimation of the potential risks, or in the case of this SHHRA, to an overly conservative RGO concentration used to determine COCs.

6.6.3 Uncertainties Associated with Toxicity Information

The methodology used to develop a noncarcinogenic toxicity value (RfD or RfC) involves identifying a threshold level below which adverse health effects are not expected to occur. The RfD and RfC values are generally based on studies of the most sensitive animal species tested (unless adequate human data are available) and the most sensitive endpoint measured. Uncertainties exist in the experimental for such animal studies. These studies are used to derive the experimental exposure representing the highest dose level tested at which no adverse effects are demonstrated [i.e., the no-observed-adverse-effect level (NOAEL)]; in some cases, however, only a lowest-observed-adverse-effect level (LOAEL) is available. The RfD and/or RfC are derived from the NOAEL (or LOAEL) for the critical toxic effect by dividing the NOAEL (or LOAEL) by uncertainty factors. These factors usually are in multipliers of 10, with each factor representing a specific area of uncertainty in the extrapolation of the data. For example, an uncertainty factor of 100 is typically used when extrapolating animal studies to humans. Additional uncertainty factors are sometimes necessary when other experimental data limitations are found. Because of the large uncertainties (10 to 10,000) associated with some RfD or RfC toxicity values, exact safe levels of exposure for humans are not known. For noncarcinogenic effects, the amount of human variability in physical characteristics is important in determining the risks that can be expected at low exposures and in determining the NOAEL (EPA 1989c).

The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. The toxicological data (CSFs and RfDs) for dose-response relationships of chemicals are frequently updated and revised, which can lead to overestimation or underestimation of risks. These values are often extrapolations from animals to humans, and this can also cause uncertainties in toxicity values because differences can exist in chemical absorption, metabolism, excretion, and toxic response between animals and humans.

EPA considers differences in body weight, surface area, and pharmacokinetic relationships between animals and humans to minimize the potential to underestimate the dose-response relationship; as a result, more conservatism is usually incorporated into these steps. In particular, toxicity factors that have high uncertainties may change as new information is evaluated. Therefore, a number of the COCs—particularly those with high uncertainties—may be subject to change. Finally, the toxicity of a contaminant may vary significantly with the chemical form present in the exposure medium. For example, some metals may be deemed as COCs because they are conservatively assumed to be in their most toxic forms (by using conservative screening RGOs to determine COCs).

The carcinogenic potential of a chemical can be estimated through a two-part evaluation involving (1) a WOE assessment to determine the likelihood that a chemical is a human carcinogen, and (2) a slope factor assessment to determine the quantitative dose-response relationship. Uncertainties occur with both assessments. Chemicals fall into one of five groups on the basis of WOE studies of humans and laboratory animals (EPA 2004): (1) Group A – known human carcinogen; (2) Group B – probable human carcinogen based on limited human data or sufficient evidence in animals, but inadequate or no evidence in humans; (3) Group C – possible human carcinogens; (4) Group D – not classified as to human carcinogenicity; and (5) Group E – evidence of no carcinogenic effects in humans.

The CSF for a chemical is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. It is used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. The slope factor is derived by applying a mathematical model to extrapolate from a relatively high administered dose to animals to the lower exposure levels expected for humans. The slope factor represents the UCL_{95} on the linear component of the slope (generally the low-dose region) of the tumorigenic dose-response curve. A number of low-dose extrapolation models have been developed, and EPA generally uses the linearized multistage model in the absence of adequate information to support other models.

For several analytes, no toxicity information for either the noncarcinogenic or carcinogenic health effects to humans is available in EPA's IRIS (EPA 2004) or HEAST (EPA 1997b). The carcinogenic potential has not been evaluated for some chemicals lacking EPA-approved toxicity values. In addition, some analytes have been assigned a WOE classification for carcinogenicity (EPA 1989c) but have not been assigned a slope factor. Therefore, until and unless additional toxicity information allows the derivation of toxicity factors, potential risk from certain analytes cannot be quantified.

Uncertainties are associated with the GAF values used to modify the oral toxicity values to evaluate dermal toxicity. Similar uncertainties are associated with the TEF values used to evaluate exposure to PAHs. Many potential uncertainties are associated with the toxicity data used in this SHHRA and can affect the RGOs and the COC determinations.

In the absence of EPA-approved toxicity values for benzo(*a*)pyrene, withdrawn or provisional values have been used in the risk characterization for this COPC. The toxicity values for this chemical have larger uncertainties than other approved values. Because this COPC is identified as a COC in this SHHRA, caution should be used, and a closer look at the withdrawn/provisional value(s) is appropriate when making remediation decisions for this COC.

6.6.4 Uncertainties and Assumptions in the Risk Characterization

Risk assessment, as a scientific activity, is subject to uncertainty. This is true even though the methodology used in this SHHRA follows EPA guidelines. As noted previously, the risk evaluation in this report is subject to uncertainty pertaining to sampling and analysis, selection of COPCs, exposure estimates, and availability and quality of toxicity data.

For this SHHRA, the method for determining COCs is the main uncertainty for the risk characterization. Note that HQs and ILCRs are not quantified in this SHHRA. However, the process of comparing the EPCs to screening RGOs at specific risk and hazard levels for specific receptors is equivalent to determining if the specific risk and hazard levels are exceeded. The use of a hazard level of 0.1 to determine the screening RGO is conservative. This process (using the 0.1 hazard level for screening) is used to conservatively guard against the possibility of missing noncarcinogenic COCs, which could potentially result in a cumulative hazard of greater than 1 if present in large numbers with similar toxic effects. Similarly, a 10^{-6} risk level is used for screening to guard against the possibility of missing carcinogenic COCs, which could potentially result in a cumulative risk of greater than 10^{-5} if present in large numbers.

Six COPCs [2-amino-4,6-DNT; 4-amino-2,6-DNT; acenaphthylene; benzo(*g,h,i*)perylene; nitrocellulose; and phenanthrene] could not be evaluated quantitatively due to the lack of toxicity information and/or values. This results in another uncertainty for this SHHRA.

6.7 SUMMARY AND CONCLUSIONS

This SHHRA was conducted to identify COCs and RGOs for contaminated media at the RVAAP Load Line 3 AOC for three potential future use scenarios: National Guard use, recreational use, and residential use. Results have been presented for all scenarios and exposure pathways. The following steps were used to generate conclusions regarding human health risks and hazards associated with contaminated media at Load Line 3:

- identification of COPCs,
- calculation of EPCs for COPCs,
- calculation of screening RGOs,
- identification of COCs, and
- calculation of risk-based RGOs to move forward to the FS.

COCs are determined for National Guard receptors (Trainee, Security Guard/Maintenance Worker, and Fire/Dust Suppression Worker), recreational receptors (Hunter/Trapper/Fisher), and residential receptors (Resident Subsistence Farmer Adult and Child). A COC summary is presented in Table 6-4, with results discussed below for each medium. Risk-based RGOs have been calculated and presented for all medium-specific COCs (see Tables 6-5 through 6-10). Risk-based RGOs are calculated for all chemicals identified as COCs for any receptor (e.g., arsenic is identified as a COC in surface water for the resident farmer only; however, risk-based RGOs are calculated for this metal for all receptors exposed to surface water). For each medium, ratios of EPCs to RGOs are used to provide an estimate of cancer risk; similar estimates are not provided for noncarcinogenic hazards, as an exceedance of the noncarcinogenic RGO is an indication of a hazard greater than one (the noncarcinogenic threshold).

6.7.1 Groundwater

One COC (2,4,6-TNT) was identified for the National Guard Trainee exposed via potable use of groundwater; this COC and five additional COCs (manganese, RDX, heptachlor epoxide, beta-BHC, and carbon tetrachloride) were identified for the On-Site Residential Farmer scenarios. For these groundwater COCs, ratios of EPCs to RGOs indicate that estimated cancer risks would be less than 10^{-6} for the National Guard Trainee and between 10^{-6} and 10^{-5} for the residential farmer scenarios. These are hypothetical future scenarios; no receptors are currently using groundwater from the AOC for any purpose.

6.7.2 Surface Water and Sediment

Exposure to surface water and sediment was evaluated for five receptor scenarios: National Guard Fire/Dust Suppression Worker, National Guard Trainee, Hunter/Trapper/Fisher, and Resident Farmer (adult and child). Manganese was the only surface water COC identified for the National Guard Trainee; this COPC and arsenic were identified for the On-Site Residential Farmer scenarios also. For the surface water COCs, ratios of EPCs to RGOs indicate that estimated cancer risks would be less than 10^{-6} for the two National Guard receptors, as well as for the Hunter/Trapper/Fisher; estimated cancer risks would be between 10^{-6} and 10^{-5} for the residential farmer scenarios.

Three chemicals were identified as sediment COCs for the Resident Farmer scenario only: antimony, PCB-1254, and benzo(*a*)pyrene. For the sediment COCs, ratios of EPCs to RGOs indicate that estimated cancer risks would be less than 10^{-6} for the two National Guard receptors, as well as for the Hunter/Trapper/Fisher; estimated cancer risks would be at or slightly above 10^{-6} for the residential farmer scenarios.

6.7.3 Soil

Surface soil was evaluated at seven EUs; subsurface soil was evaluated at three EUs. Direct contact (ingestion, dermal contact, and inhalation) with surface and subsurface soils was evaluated for six receptors: National Guard Security Guard/Maintenance Worker (shallow surface soil), National Guard Fire/Dust Suppression Worker (shallow surface soil), National Guard Trainee (deep surface soil), Hunter/Trapper/Fisher (shallow surface soil), and Resident Farmer (adult and child) (shallow surface soil and subsurface soil). The following summarizes the resulting COCs in soil at Load Line 3.

- Twenty-one Load Line 3 COCs were identified for shallow surface soil, including 7 metals (aluminum, antimony, arsenic, barium, cadmium, manganese, and thallium), 4 explosives (1,3-DNB; 2,4,6-TNT; 2,4-DNT; and RDX), 2 PCBs (PCB-1254 and PCB-1260), 3 pesticides (4,4'-DDE; dieldrin; and heptachlor), and 5 PAHs [benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(1,2,3-*cd*)pyrene]. The number of shallow surface soil COCs varied for each receptor, with 2 COCs for the Hunter/Trapper/Fisher; 3 COCs for the Fire/Dust Suppression Worker, 13 COCs for the Security Guard/Maintenance Worker, 17 COCs for the Resident Farmer Adult, and 21 COCs for the Resident Farmer Child. The number of shallow surface soil COCs identified for each EU also varied: 3 for both the DLA Storage Tanks and Change Houses Aggregates, 8 for the Preparation and Receiving Areas Aggregate, 10 for the Packaging and Shipping Areas Aggregate, 11 for both the Perimeter Area and West Ditches Aggregates, and 16 for the Explosives Handling Areas Aggregate.

  Ratios of EPCs to RGOs provide an indication of estimated cancer risks. Most COCs have EPCs that would produce cancer risks of less than 10^{-5}; a handful of COCs would produce risks in excess of 10^{-5} for receptors other than the resident farmer: PCB-1254 in six of the seven aggregates (all except the DLA Storage Tanks Aggregate; estimated risk for PCB-1254 would exceed 10^{-4} for the Security Guard/Maintenance Worker in the in the Explosives Handling Areas and Packaging and Shipping Areas Aggregates); 2,4,6-TNT in the Explosives Handling Areas and Packaging and Shipping Areas Aggregates; and benzo(*a*)pyrene in the Explosives Handling Areas and West Ditches Aggregates. Estimated risks for several COCs would exceed the 10^{-5} risk level for the resident farmer scenarios, including arsenic; 2,4,6-TNT ($>10^{-4}$ in the Explosives Handling Areas Aggregate); 2,4-DNT; PCB-1254 ($>10^{-4}$ in the Explosives Handling Areas, Packaging and Shipping Areas, and Perimeter Area Aggregates); and benzo(*a*)pyrene, benzo(*b*)fluoranthene, and dibenz(*a,h*)anthracene.

- Eight Load Line 3 COCs were identified for the National Guard Trainee exposed to deep surface soil, including five metals (aluminum, arsenic, barium, cadmium, and manganese), one explosive (2,4,6-TNT), one PCB (PCB-1254), and one PAH [benzo(*a*)pyrene]. The number of deep surface soil COCs identified for each EU varied: two for the DLA Storage Tanks Aggregate, three for both the Change Houses and Preparation and Receiving Areas Aggregates, four for the West Ditches Aggregate, five for the Perimeter Area Aggregate, six for the Explosives Handling Areas Aggregate, and seven for the Packaging and Shipping Areas Aggregate.

  Ratios of EPCs to RGOs indicate that estimated cancer risks would be at or slightly above 10^{-6} for most deep surface soil COCs; two COCs would result in estimated cancer risk to the National Guard Trainee of slightly larger than 10^{-5} at the Explosives Handling Areas Aggregate (2,4,6-TNT and PCB-1254), the Packaging and Shipping Areas Aggregate (PCB-1254), and the Perimeter Area Aggregate (PCB-1254).

- Five Load Line 3 COCs were identified for the Resident Farmer (adult and child) exposed to subsurface soil, including two metals (arsenic and cadmium), two explosives (2,4,6-TNT and RDX), and one PCB (PCB-1254). The number of subsurface soil COCs identified for each EU included four for the Perimeter Area Aggregate, three for the Explosives Handling Areas Aggregate, and one for the Preparation and Receiving Areas Aggregate.

  Ratios of EPCs to RGOs provide an indication of estimated cancer risks. Estimated risks that would be greater than 10^{-5} for the resident farmer include arsenic and PCB-1254 ($>10^{-4}$) at the Explosives Handling Areas Aggregate, arsenic and 2,4,6-TNT at the Perimeter Area Aggregate, and arsenic at the Preparation and Receiving Areas Aggregate.

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