FINAL

ADDENDUM TO THE PHASE II REMEDIAL INVESTIGATION REPORT

for Erie Burning Grounds

(RVAAP-02)

Ravenna Army Ammunition Plant
Ravenna, Ohio

September 2006

US Army Corps of Engineers®
Louisville District

Contract No. GS-10F-0076J
Delivery Order No. W912QR-05-F-0033

SAIC® From Science to Solutions™

Prepared for:
U.S. Army Corps of Engineers
Louisville, Kentucky

Prepared by:
Science Applications International Corporation
8866 Commons Boulevard, Suite 201
Twinsburg, Ohio 44087

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LIST OF ACRONYMS

ALM	Adult lead model
AMSL	above mean sea level
AOC	Area of Concern
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
BERA	Baseline Ecological Risk Assessment
BGS	below ground surface
BRAC	Base Realignment and Closure
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMCOC	contaminant migration constituent of concern
CMCOPC	contaminant migration constituent of potential concern
COC	constituent of concern
COEC	constituent of ecological concern
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
cPAH	Carcinogenic polycyclic aromatic hydrocarbon
CSF	Cancer slope factor
CSM	conceptual site model
DFFO	Director's Final Findings and Orders
DNT	dinitrotoluene
EBG	Erie Burning Grounds
EPC	exposure point concentration
ERA	ecological risk assessment
ESV	ecological screening value
EU	exposure unit
FS	Feasibility Study
FWHHRAM	Facility Wide Human Health Risk Assessor Manual
GAF	Gastrointestinal absorption factor
GSA	U. S. General Services Administration
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IEUBK	Integrated Exposure Uptake Biokinetic
ILCR	incremental lifetime cancer risk
IRP	Installation Restoration Program
MCL	maximum contaminant level
MDC	maximum detected concentration
MEC	munitions and explosives of concern
MMRP	Military Munitions Response Program
NFA	no further action
NGB	National Guard Bureau

LIST OF ACRONYMS (CONTINUED)

OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PBC	Performance Based Contract
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PRG	preliminary remediation goal
PWS	Performance Work Statement
RAGS	Risk Assessment Guidance for Superfund
RBC	risk-based concentration
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RfC	Reference concentration
RfD	Reference dose
RGO	Remedial goal option
RI	Remedial Investigation
ROD	Record of Decision
RRSE	Relative Risk Site Evaluation
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation
SERA	Screening Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment Model
SMDP	Scientific decision management point
SRC	site-related contaminant
SVOC	semi-volatile organic compound
TEF	Toxicity equivalent factor
THI	target hazard index
TNT	2,4,6-trinitrotoluene
TR	target risk
TRV	toxicity reference values
USACE	U. S. Army Corps of Engineers
USACHPPM	U. S. Army Center for Health Promotion and Preventative Medicine
USATHMA	U. S. Army Toxic and Hazardous Materials Agency
USEPA	U. S. Environmental Protection Agency
USGS	U. S. Geological Society
VOC	volatile organic compound

ES.0 EXECUTIVE SUMMARY

Science Applications International Corporation (SAIC) has been contracted by the U. S. Army Corps of Engineers (USACE), Louisville District to provide environmental services to achieve remedy for (or cleanup of) soils and dry sediments at Erie Burning Grounds (EBG) (RVAAP-02). EBG is one of the six high priority areas of concern (AOCs) at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio, requiring remedy for (or cleanup of) soils and dry sediments by September 30, 2007.

The Phase II Remedial Investigation (RI) recommended EBG proceed to the Feasibility Study (FS) stage in the RVAAP Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 process. However, the Phase II RI did not contain enough information to proceed to the FS stage. Therefore this RI Addendum:

- Evaluates the fate and transport analysis conducted in the Phase II RI;
- Evaluates an Adult and Juvenile Trespasser scenario to supplement the baseline human health risk assessment (HHRA) per the Facility Wide Human Health Risk Assessor Manual (FWHHRAM) Amendment #1 (USACE 2005b) to provide risk managers with information to support determination of the need for continued security at the facility;
- Develops preliminary cleanup goals, and based on land use considerations apply risk management considerations to the HHRA completed in the Phase II RI;
- Incorporates further weight of evidence into the Ecological Risk Assessment (ERA) completed in the Phase II RI;
- Determines if EBG will require no further action (NFA) or will be the subject of an FS to evaluate potential remedies and future actions using the results of the updated risk assessments.

ES.1 SCOPE

The necessary CERCLA requirements with respect to soils and dry sediments will be performed to achieve remedy at EBG. Remediation of aqueous media (i.e., groundwater, surface water, and wet sediments) and munitions and explosives of concern (MEC) issues are not included in the scope of the Performance Based Contract (PBC). These will be addressed under future decisions.

Ohio Army National Guard (OHARNG) has established future land uses at EBG based on anticipated training mission and utilization of the Ravenna Training and Logistics Site (RTLS) (USACE 2004). These anticipated future land uses in conjunction with the evaluation of residential land use and associated receptors form the basis for identifying and evaluating future action.

ES.2 SUMMARY OF UPDATED RI EVALUATION

The operational history of EBG indicates the potential for MEC, which will be addressed under the Military Munitions Response Program (MMRP). Additionally, a substantial portion of EBG consists of high quality wetland areas, which limit potential future use. Based on these considerations, land use for EBG under a restricted (military mission) use will be controlled and an Ohio Army National Guard Dust/Fire Suppression worker is evaluated as the most likely receptor under a representative land use scenario. Hunting and trapping may also be allowed under restricted land use; however, exposure by a Hunter/Trapper is estimated to be less than for a Dust/Fire Suppression worker. Therefore, any recommendations protective of a Dust/Fire Suppression worker will also be protective of a Hunter/Trapper. A residential land use scenario is also evaluated to provide a baseline for evaluating whether EBG may be eligible for residential release; however, due to the considerations noted above, a residential land use is not considered a reasonable foreseeable land use at the current time.

ES.2.1 Fate and Transport Assessment of COCs in Soils

Nature and extent of contamination was previously defined in the Phase II RI. Based on the analyses of the fate and transport assessment performed in support of the Phase II RI for EBG, no constituents of concern (COCs) were identified for further analysis using the Seasonal Soils Compartment Model (SESOIL)/Analytical Transient 1-, 2-, 3-Dimensional (AT123D) models previously developed. Impacted soils at EBG are not predicted to impact underlying groundwater beneath the AOC. Therefore, soil remediation for protection of groundwater is not required at EBG and the AOC may be released for residential land use with respect to future groundwater impacts from impacted soils.

ES.2.2 Identification of Human Health Preliminary Cleanup Goals for EBG

Preliminary cleanup goals were developed for soil at EBG. Preliminary cleanup goals are the chemical-specific, risk-based values used to meet the objective for protection of human health. A summary of the preliminary cleanup goals for the COCs identified for evaluation is provided below in Table ES-1 for the representative receptor (Dust/Fire Suppression Worker) and Resident Subsistence Farmer land use.

Table ES-1. Summary of COCs and Preliminary Cleanup Goals for Evaluation of Remedial Alternatives for EBG

COC	Soil Preliminary Cleanup Goal (mg/kg)	Sediment[a] Preliminary Cleanup Goal (mg/kg)	Surface Water Preliminary Cleanup Goal (mg/L)	Groundwater Preliminary Cleanup Goal (mg/L)
Representative Land Use (Restricted Access – Fire/Dust Suppression Worker)				
None	--	--	--	--
Residential Land Use (Resident Subsistence Farmer)				
Antimony	--	31	--	--

-- = Constituent is not a COC for evaluation of remedial alternatives for this medium.
COC = Constituent of concern..
[a]Sediment at EBG is wet.

ES.2.3 Ecological Preliminary Cleanup Goals for EBG

Ohio Environmental Protection Agency (Ohio EPA) guidance (Ohio EPA 2003) allows decisions regarding the need for remediation to be made at the completion of each level of the ecological risk assessment (ERA) process. The remedial alternatives evaluation process includes the development of preliminary cleanup goals or constituents of ecological concern (COEC) concentrations used to define areas where remediation is needed to achieve protectiveness for ecological resources. A decision whether it is necessary to remediate because of potential harm to ecological receptors and whether it is necessary to set preliminary cleanup goals for ecological receptors at EBG is not included in the RI Report. Weight-of-evidence discussions in this RI Addendum provide input for that decision. A Level II Screening Ecological Risk Assessment (SERA) and a Level III Baseline Ecological Risk Assessment (BERA) were conducted at EBG.

It is recommended that no quantitative preliminary cleanup goals to protect ecological receptors be developed at EBG. This recommendation comes from applying steps in the Facility-Wide Ecological Risk Work Plan and especially steps in Figure III to reach a Scientific Management Decision Point (SMDP) that few ecological resources are at risk. This recommendation is based principally on the following three weight-of-evidence conclusions:

- Field observations (Level I of Ohio EPA protocol, Ohio Rapid Assessment Method for Wetlands with its high score of 81, and Facility-Wide Biological and Surface Water Study) indicate that surface water and wetlands portions of EBG represent a unique resource in the form of a Category 3 wetland (highest evaluation). Also, field reconnaissance (USACE 2005c) indicates that the terrestrial portion of EBG represents an ecological resource typical of many nearby and other RVAAP habitats.

- Soil hazard quotients (HQs) are generally not highly elevated and impacts to aquatic and terrestrial ecological resources are not observed nor expected. Regardless, some ecological risk from chemicals has been predicted in both the wetland and terrestrial portions of EBG.

- Removal of soil or sediment to further reduce any adverse ecological effects from chemicals could destroy unique wetland resources and terrestrial habitat without substantial benefit to those same ecological resources at EBG.

ES.3 RECOMMENDATIONS

NFA with respect to impacted soils and dry sediments is recommended at EBG. No human health COCs are identified for evaluation of remedial alternatives in soils and dry sediments for the Fire/Dust Suppression Worker land use or Resident Subsistence Farmer land use at EBG. One COC was identified in wet sediments for the residential land use scenario. Wet sediment is not included in the NFA recommendation for soils and dry sediments. The ecosystems, including wetlands, are healthy and functioning and no preliminary cleanup values for ecological resources are recommended. Any required land use controls to address MEC issues will be developed and

implemented by the US Army and OHARNG under the auspices of the MMRP. These land use controls may also be tailored to simultaneously ensure protectiveness with respect to wetland areas/wet sediments.

Recommendations regarding wet sediments, surface water, and groundwater are not within the scope of this RI Addendum and any necessary action with respect to these media will be established in future decisions

1.0 INTRODUCTION

Science Applications International Corporation (SAIC) has been contracted by the U. S. Army Corps of Engineers (USACE), Louisville District to provide environmental services to achieve remedy for (or cleanup of) soils and dry sediments at Erie Burning Grounds (EBG) (RVAAP-02) at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio by September 30, 2007.

This work is being performed under a firm fixed price basis in accordance with U. S. General Services Administration (GSA) Environmental Advisory Services Contract GS-10-F-0076J under a Performance Based Contract (PBC) as specified in the Performance Work Statement (PWS) issued by the US Army on February 10, 2005 (USACE 2005d). In addition, planning and performance of all elements of this work will be in accordance with the requirements of the Director's Final Findings and Orders (DFFO) dated June 10, 2004 [Ohio Environmental Protection Agency (Ohio EPA) 2004a].

This document is included as an addendum to the approved Phase II Remedial Investigation (RI) Report for EBG (USACE 2005c). This RI Addendum further addresses soils under the scope of the PBC contract. In addition, surface water and wet sediments are considered in the human health risk assessment (HHRA) evaluation. The wetland at EBG continuously contains water; therefore, all the sediments are considered wet. Remedy for (or cleanup of) aqueous media (groundwater, surface water and wet sediments) is not included in the scope of this PBC contract but will be addressed under future decisions.

1.1 PURPOSE AND SCOPE

The Phase II RI recommended EBG proceed to the Feasibility Study (FS) stage in the RVAAP Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process. It was further recommended, based on land use considerations, for risk managers to (1) identify the need for any additional human health risk evaluation or preliminary cleanup goal development, and (2) determine if further evaluation of ecological risks may be required, or if ecological preliminary cleanup goals are required for the area of concern (AOC). This RI Addendum is prepared to:

- Evaluate the fate and transport analysis conducted in the Phase II RI;
- Evaluate an Adult and Juvenile Trespasser scenario to supplement the baseline HHRA per the Facility Wide Human Health Risk Assessor Manual (FWHHRAM) Amendment #1 (USACE 2005b) to provide risk managers with information to support determination of the need for continued security at the facility;
- Develop preliminary cleanup goals, and based on land use considerations apply risk management considerations to the HHRA completed in the Phase II RI;
- Incorporate further weight of evidence into the Ecological Risk Assessment (ERA) completed in the Phase II RI; and

- Determine if EBG will require no further action (NFA) or will be the subject of a FS to evaluate potential remedies and future actions using the results of the updated risk assessments.

The necessary CERCLA requirements with respect to soils and dry sediments will be performed to achieve remedy at EBG. Removal actions specifically addressing munitions and explosives of concern (MEC) issues or potential environmental impact from MEC removal are not included in this RI Addendum.

Ohio Army National Guard (OHARNG) has established future land uses at EBG based on anticipated training mission and utilization of the Ravenna Training and Logistics Site (RTLS) (USACE 2004). These anticipated future land uses, in conjunction with the evaluation of residential land use and associated receptors, form the basis for identifying and evaluating any necessary future action.

1.2 FACILITY-WIDE BACKGROUND INFORMATION

1.2.1 General Facility Description

When the RVAAP Installation Restoration Program (IRP) began in 1989, the RVAAP was identified as a 21,419-acre installation. The property boundary was resurveyed by the OHARNG over a two year period (2002 and 2003) and the actual total acreage of the property was found to be 21,683.289 acres. As of February 2006, a total of 20,403 acres of the former 21,683 acre RVAAP have been transferred to the National Guard Bureau (NGB) and subsequently licensed to the OHARNG for use as a military training site. The current RVAAP consists of 1,280 acres scattered throughout the OHARNG RTLS.

The RTLS is in northeastern Ohio within Portage and Trumbull Counties, approximately 4.8 km (3 miles) east-northeast of the city of Ravenna and approximately 1.6 km (1 mile) northwest of the city of Newton Falls. The RVAAP portions of the property are solely located within Portage County. The RTLS/RVAAP is a parcel of property approximately 17.7 km (11 miles) long and 5.6 km (3.5 miles) wide bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad on the south; Garret, McCormick, and Berry roads on the west; the Norfolk Southern Railroad on the north; and State Route 534 on the east (see Figures 1-1 and 1-2). The RTLS is surrounded by several communities: Windham on the north; Garrettsville 9.6 km (6 miles) to the northwest; Newton Falls 1.6 km (1 mile) to the southeast; Charlestown to the southwest; and Wayland 4.8 km (3 miles) to the south.

When the RVAAP was operational, the RTLS did not exist and the entire 21,683-acre parcel was a government-owned, contractor-operated industrial facility. The RVAAP IRP encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP, and therefore references to the RVAAP in this document are considered to be inclusive of the historical extent of the RVAAP, which is inclusive of the combined acreages of the current RTLS and RVAAP, unless otherwise specifically stated.

Industrial operations at the former RVAAP consisted of 12 munitions-assembly facilities referred to as "load lines." Load Lines 1 through 4 were used to melt and load 2,4,6-trinitrotoluene (TNT) and Composition B into large-caliber shells and bombs. The operations on the load lines produced explosive dust, spills, and vapors that collected on the floors and walls of each building. Periodically, the floors and walls were cleaned with water and steam. The liquid, containing TNT and Composition B, was known as "pink water" for its characteristic color. Pink water was collected in concrete holding tanks, filtered, and pumped into unlined ditches for transport to earthen settling ponds. Load Lines 5 through 11 were used to manufacture fuzes, primers, and boosters. Potential contaminants in these load lines include lead compounds, mercury compounds, and explosives. From 1946 to 1949, Load Line 12 was used to produce ammonium nitrate for explosives and fertilizers prior to its use as a weapons demilitarization facility.

In 1950, the facility was placed in standby status and operations were limited to renovation, demilitarization, and normal maintenance of equipment, along with storage of munitions. Production activities were resumed from July 1954 to October 1957 and again from May 1968 to August 1972. In addition to production missions, various demilitarization activities were conducted at facilities constructed at Load Lines 1, 2, 3, and 12. Demilitarization activities included disassembly of munitions and explosives melt-out and recovery operations using hot water and steam processes. Periodic demilitarization of various munitions continued through 1992.

In addition to production and demilitarization activities at the load lines, other facilities at RVAAP include AOCs that were used for the burning, demolition, and testing of munitions. These burning and demolition grounds consist of large parcels of open space or abandoned quarries. Potential contaminants at these AOCs include explosives, propellants, metals, waste oils, and sanitary waste. Other types of AOCs present at RVAAP include landfills, an aircraft fuel tank testing facility, and various general industrial support and maintenance facilities.

1.2.2 Demography and Land Use

RVAAP consists of 8,775 hectares (21,683 acres) and is located in northeastern Ohio, approximately 37 km (23 miles) east-northeast of Akron and 48.3 km (30 miles) west-northwest of Youngstown. RVAAP occupies east-central Portage County and southwestern Trumbull County. U. S. Census Bureau population estimates for 2001 indicate that the populations of Portage and Trumbull counties are 152,743 and 223,982, respectively. Population centers closest to RVAAP are Ravenna, with a population of 12,100, and Newton Falls, with a population of 4,866.

The RVAAP facility is located in a rural area and is not close to any major industrial or developed areas. Approximately 55% of Portage County, in which the majority of RVAAP is located, consists of either woodland or farmland acreage. The closest major recreational area, the Michael J. Kirwan Reservoir (also known as West Branch Reservoir), is located adjacent to the western half of RVAAP south of State Route 5.

RVAAP is operated by the Base Realignment and Closure (BRAC) Division. The BRAC Division controls environmental AOCs at RVAAP. The NGB controls non-AOC areas and has licensed these areas

to OHARNG for training purposes. Training and related activities at RTLS include field operations and bivouac training, convoy training, equipment maintenance, C-130 aircraft drop zone operations, helicopter operations, and storage of heavy equipment. As environmental AOCs are investigated and addressed or remediated, if needed, transfer of these AOCs from the BRAC Division to NGB is conducted.

OHARNG has prepared a comprehensive Environmental Assessment and an Integrated Natural Resources Management Plan to address future use of RTLS property (OHARNG 2001). The perimeter of RVAAP is currently fenced and the perimeter is patrolled intermittently by the facility caretaker contractor. Access to RVAAP is strictly controlled and any contractors, consultants, or visitors who wish to gain access to the facility must follow procedures established by RVAAP and the facility caretaker contractor.

1.3 ERIE BURNING GROUNDS

1.3.1 EBG History

EBG is located in the northeastern corner of the RVAAP facility and is approximately 35 acres in size (Figure 1-2). The area may have been used for brick manufacturing prior to its acquisition by the US Army in 1940. From 1941 to 1951, the AOC was used to perform open burning of explosives and related materials. This included bulk, obsolete, and off-specification explosives, propellants, rags, railcars used for transporting explosives, and unspecified large metal items. Once burned, the metal items were salvaged and processed as scrap. Ash residues were not removed. Historically, a waste chute ran from the end of rail line Track 49 to the former burn area. In addition, the borrow area between Tracks 49 and 10 may have also been used for open burning. In the 1990s the area became a wetland due to sedimentation, vegetation growth, and beaver activity, which plugged the primary outflow culvert and small streams that drained EBG. The wetlands now cover approximately 60% of the AOC.

Potential primary sources of contamination include the Track 49 embankment, the gravel access road, and the north leg of the T-area. Potential secondary sources of contamination are the sediments in the Former Burn Area, the north side of the Track 49 embankment, the north leg of the T-area, and the north end of the gravel access road.

EBG is managed as “Restricted Access” because of environmentally sensitive areas (i.e., wetlands) and the potential for MEC (although minimal MEC has been found). Current plans call for EBG to remain Restricted Access in the future. This means this area will not be opened to general training, primarily because it is a wetland. EBG is closed to all normal training and administrative activities. Surveying, sampling, and other essential security, safety, and natural resources management activities may be conducted here only after personnel are properly briefed on potential hazards/sensitive areas. Individuals unfamiliar with the hazards/restrictions are escorted by authorized personnel at all times while in the restricted area (USACE 2004).

1.3.2 Previous Investigations

Five investigations have been completed at EBG:

- Ravenna Arsenal, Ravenna, Ohio (Mogul Corporation 1982);
- Ravenna Water Quality Surveillance Program (U. S. Army Toxic and Hazardous Materials Agency (USATHMA) 1980-1992];
- Relative Risk Site Evaluation (RRSE), RVAAP, Ravenna, Ohio, Hazardous and Medical Waste Study, No. 37-EF-5360-97 [U. S Army Center for Health Promotion and Preventive Medicine (USACHPPM) 1996];
- Phase I RI Report for EBG at the RVAAP, Ravenna, Ohio, DACA62-94-D-0029 (USACE 2001); and
- Phase II RI Report for EBG at the RVAAP, Ravenna, Ohio (USACE 2005c).

The Water Quality Surveillance Program monitored surface water and sediments and included the Parshall flume located near the eastern boundary of the installation, and adjacent to Route 534 where surface water from EBG, along with that of Load Line 1, leaves the installation through this sampling point (PF534). The RRSE performed for EBG was limited to surface water and sediments. The Phase I RI analyzed contaminant concentrations and evaluated the human health and ecological risks for soils, sediments, and surface water, but not groundwater. The Phase II RI included groundwater characterization efforts. The RI subsurface soil samples were collected to a depth of 3 ft below ground surface (BGS).

1.4 REPORT ORGANIZATION

This report presents the updated findings of the remedial investigation conducted for EBG and is organized as follows:

- Chapter 2 presents the environmental setting;
- Chapter 3 summarizes the nature and extent determined in the Phase II RI for the constituents and media of concern;
- Chapter 4 presents the updated contaminant fate and transport analysis;
- Chapter 5 presents the updated HHRA including development of preliminary cleanup goals;
- Chapter 6 presents the updated ERA;

- Chapter 7 presents conclusions and recommendations; and

- Chapter 8 cites the references used in this report.

The appendix following the main text provides information supporting the evaluations presented in the body of this RI Addendum:

- Appendix A: Risk Characterization for Trespasser (Adult and Juvenile) Scenario.

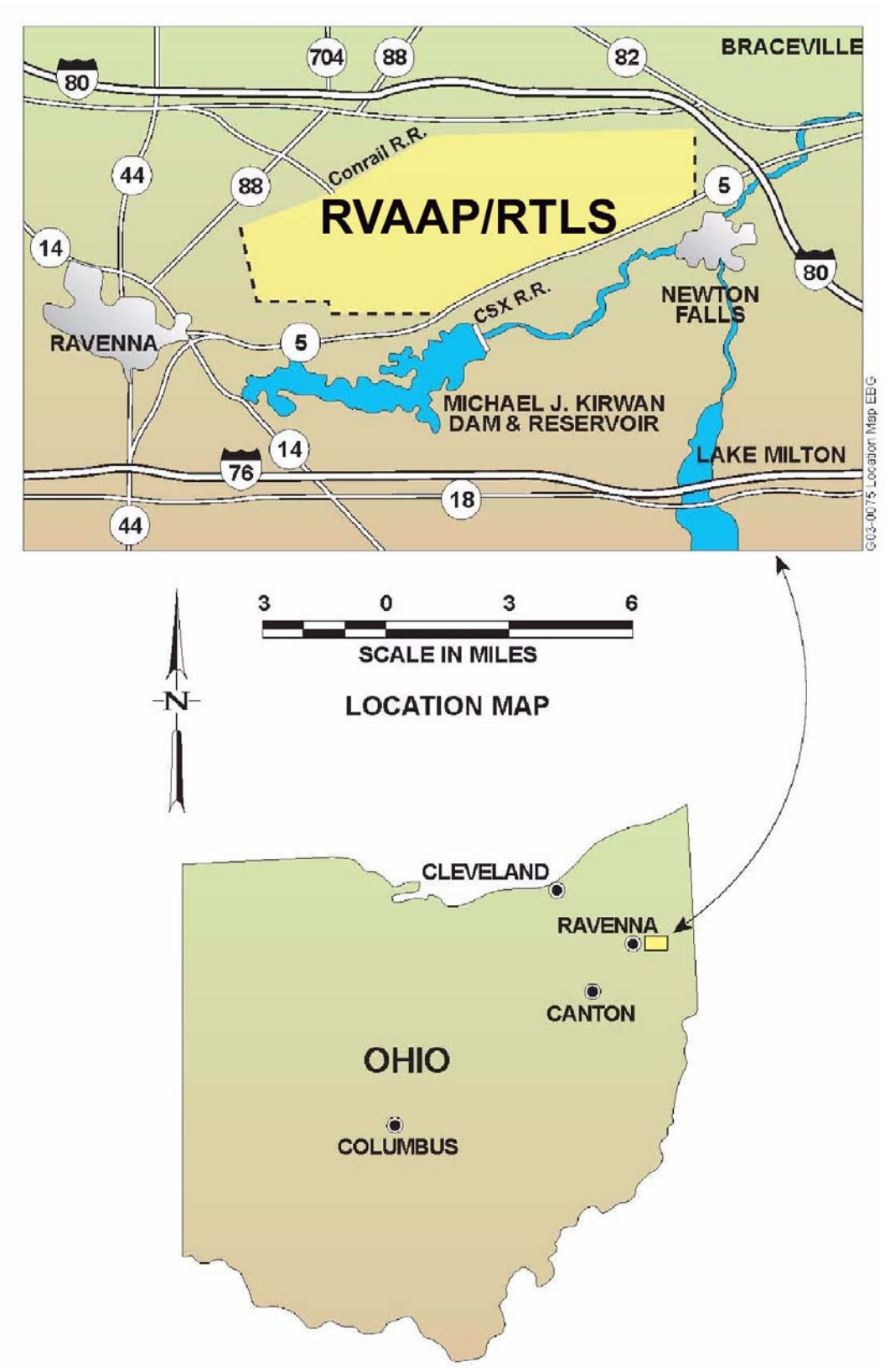

Figure 1-1. General Location and Orientation of RVAAP

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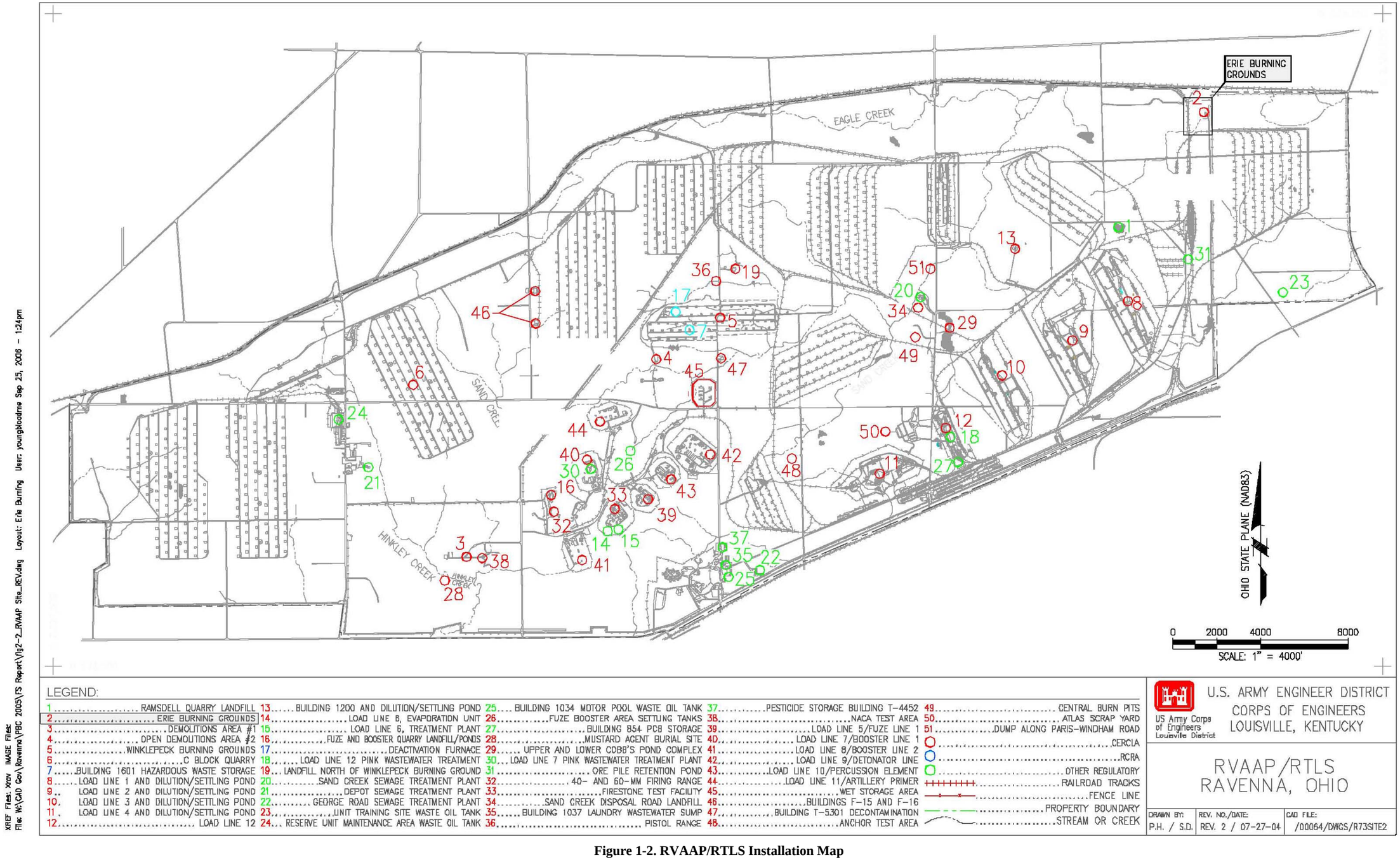

Figure 1-2. RVAAP/RTLS Installation Map

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2.0 ENVIRONMENTAL SETTING

Chapter 2 of the Phase II RI Report for EBG (USACE 2005c) describes the physical characteristics of EBG and the surrounding environment that are factors in understanding potential contaminant transport pathways, receptors, and exposure scenarios for human health and ecological risks. The geology, hydrogeology, climate, and ecological characteristics of RVAAP were originally presented in Chapter 2.0 of the Phase I RI for EBG (USACE 2001).

2.1 RVAAP PHYSIOGRAPHIC SETTING

RVAAP is located within the Southern New York Section of the Appalachian Plateau physiographic province [U. S. Geological Survey (USGS) 1968]. This province is characterized by elevated uplands underlain primarily by Mississippian- and Pennsylvanian-age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography with incised streams having dendritic drainage patterns. The Southern New York Section has been modified by glaciation, which rounded ridges, filled major valleys, and blanketed many areas with glacially derived unconsolidated deposits (i.e., sand, gravel, and finer-grained outwash deposits). As a result of glacial activity in this section, old stream drainage patterns were disrupted in many locales, and extensive wetland areas developed.

2.2 SURFACE FEATURES

Elevations at EBG range from approximately 285.9-287.2 m (938.1-942.4 ft) above mean sea level (AMSL) (Figure 2-1). Extensive beaver damming has turned a large portion of the AOC into wetlands. There are four main surface water basins occupying the lowlands. The largest pond, North Surface Water Basin, has a depth of 5 ft in the former drainage channel, but is less than 1 ft in other areas. Surface water flows from a culvert pipe and drainage ditch in the north and drains to the southwest through a pipe beneath Track 10. Photograph 2-1 gives an indication of the amount of water at EBG. Overall, the AOC is estimated to be 60% aquatic habitat. Structural features include a gravel access road, a 1,700-ft long main drainage channel, three pairs of 250-ft long trenches, rail line Track 10, rail line Track HA, and rail line Track 49. There are no buildings and no historical evidence of permanent buildings. The area near the remains of Track 49 is littered with railroad ties and miscellaneous associated metal debris, such as rail spikes and plates. Wooden frame structures in the vicinity of the former waste chute and burn area were observed during low water conditions at the time of the Phase I RI. Wooden frame debris in the vicinity of the former burn area at the end of Track 49 were observed during low water conditions at the time of the Phase I RI and are believed to be remnants of a wooden chute used to offload materials for burning.

Photograph 2-1. Conditions at EBG, September 2005

The soils in the area are predominantly silty loams. Historically, the native soils have been disturbed by the construction of the railroad tracks and access road. In these areas, the native soils were replaced with sandy fill, sand, ballast material, and slag. Near the access road, the soils are comprised of dark clayey silts and silty clays.

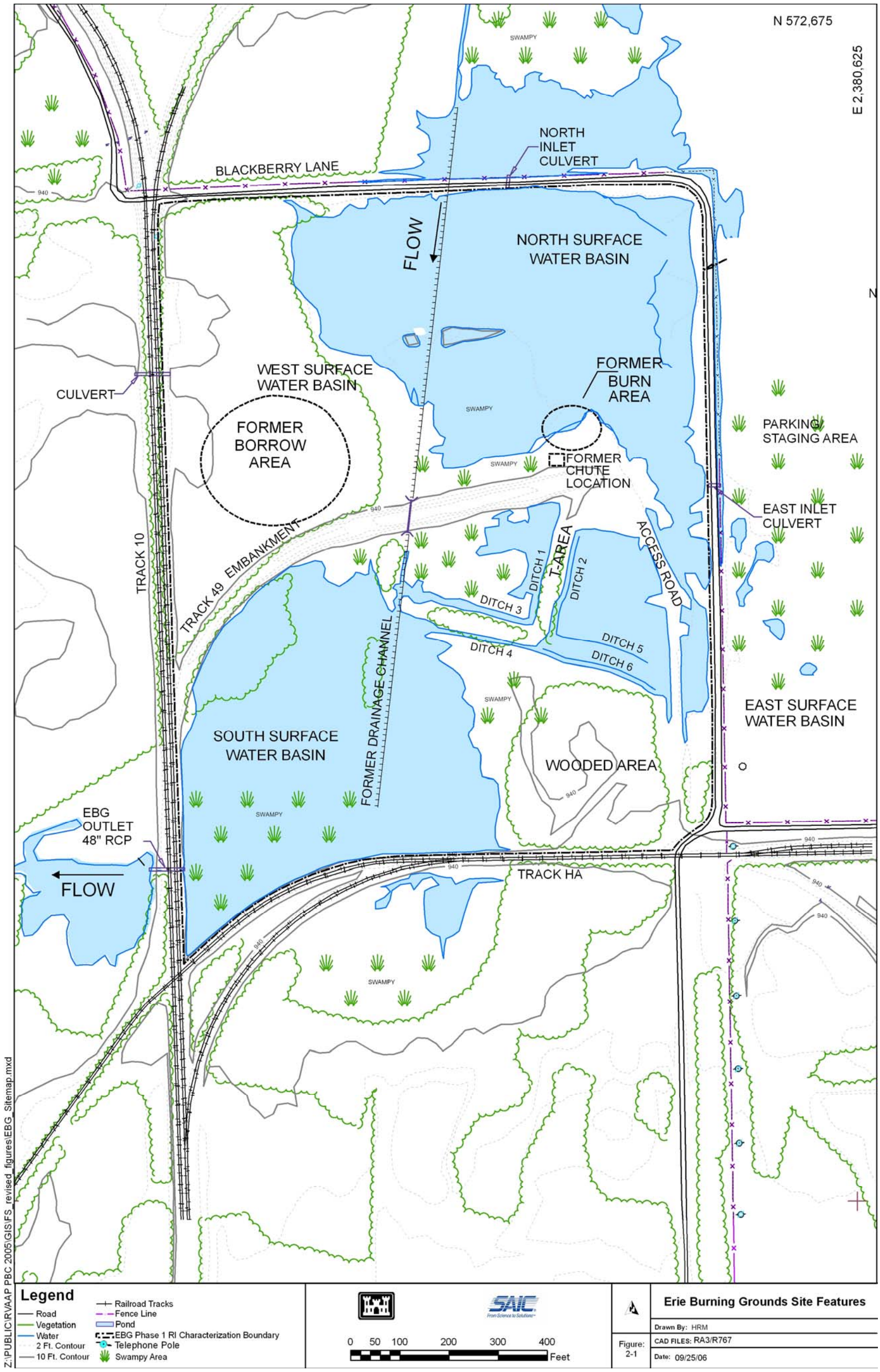

Figure 2-1. Features of EBG

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3.0 NATURE AND EXTENT

Nature and extent of contamination at EBG was determined based on the evaluation of the Phase I and II RI data. Nature and extent was fully delineated at EBG as presented in Chapter 4 of the Phase II RI Report for EBG (USACE 2005c).The following sections provide a summary of the nature and extent by media. Figure 3-1 shows the sample locations and groundwater monitoring wells at EBG.

3.1 SURFACE SOIL DISCRETE SAMPLES

Explosives were detected along the north and south embankment of Track 49. No explosives were found in the wooded area in the northwest portion of the AOC. Inorganic site-related contaminants (SRCs) included between 10 and 14 metals in each of the Phase II sample locations on the north and south sides of Track 49 embankment. With the exception of cadmium, metals were not present above background in the wooded area in the northwest or southeast portions of the AOC. Polychlorinated biphenyls (PCBs) were not detected in Phase I or Phase II RI surface soil samples (0-1 ft BGS).

3.2 SURFACE SOIL MULTI-INCREMENT SAMPLES

Multi-increment soil samples were collected from five separate areas at EBG. Explosives were detected at one multi-increment sample location from the north Track 49 embankment area. Between 2 and 14 inorganic constituents were identified above background in the multi-increment sample areas. At least one, and as many as 12, semi-volatile organic compounds (SVOCs) were detected in four of the five multi-increment samples collected. SVOCs were not detected on the south of the embankment. The greatest number of SVOCs was also observed in the multi-increment sample from the north Track 49 embankment. Seven SVOCs were detected in the vicinity of the Former Borrow Area.

3.3 SEDIMENT SAMPLES

Explosives or propellants in sediments were detected at the north inlet (nitrobenzene) and in the former drainage channel in the south basin (octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine). Explosives were not detected in the sediment samples collected downstream of the EBG outlet. Inorganic SRCs were observed at the north and east inlets, the former drainage channel in the south basin, and downstream of the EBG outlet. Bis(2-ethylhexyl)phthalate was detected in five of six sediment samples, and fluoranthene was detected downstream of the EBG outlet. SVOCs were not detected in the surface water basins or beyond the AOC boundary in the Phase I investigation. Volatile organic compounds (VOCs) were also detected at the EBG outlet and stations downstream. PCBs were not detected in Phase II RI samples. Methoxychlor was detected in the Phase II RI sediment sample from the former drainage channel in the south basin.

3.4 SEDIMENT MULTI-INCREMENT SAMPLES

Three multi-increment samples were collected from each of two multi-increment sampling areas, one located in the north basin, and one in the south basin along the axis of the former drainage channel. Overall, explosives, metals, SVOCs, and pesticides were more prevalent in the north basin multi-increment samples than in the south basin multi-increment samples.

3.5 SURFACE WATER SAMPLES

Explosive compounds were not detected at the eight surface water stations sampled during the Phase II RI. The propellant nitrocellulose was detected in the Phase II surface water sample collected from the east inlet. A total of seven metals were detected above background criteria at least once in Phase II surface water samples: antimony, beryllium, cadmium, cobalt, lead, nickel, and vanadium. The background criterion for all seven metals is zero, as they were not detected in the background data set. As was seen for Phase II sediments, the greatest number of metals above background occurred in the sample collected from the former drainage channel in the south basin. This area was identified as having only minor contamination in the Phase I RI. Metals were detected above background at the EBG outlet and stations immediately downstream, as well as the offsite location at PF534. The offsite sample point at PF534 also contained inorganic SRCs above background criteria during the Phase I RI. SVOCs, pesticides, and PCBs were not detected in Phase II surface water samples. The Phase II RI samples had detectable VOCs for samples collected in the T-Area and at the east inlet, which was also noted in the Phase I RI and at PF534; VOCs had not been detected previously at the PF534 location. The VOCs most frequently detected in Phase I samples (acetone, toluene, carbon disulfide) were not detected in Phase II samples. PCBs were not detected in either the Phase I or Phase II RIs.

3.6 GROUNDWATER

Explosives were not detected in any of the groundwater wells installed and sampled during the Phase II RI. Nine inorganic SRCs were detected in at least one of the eight EBG monitoring wells (antimony, arsenic, barium, cobalt, copper, lead, nickel, vanadium, and zinc). Metals were detected above background criteria as often in wells located at the AOC boundary on the northeast and southwest corners (i.e., upgradient and downgradient) of EBG as in wells located in areas of known surface soil (0-1 ft BGS) and sediment contamination. Maximum concentrations of SRCs ranged from 2 to 3 times background for those constituents whose background criteria were greater than zero.

Two SVOCs, bis(2-ethylhexyl)phthalate and di-n-butyl phthalate, were detected in one to two wells. The occurrence of SVOCs in groundwater was focused on wells located in the Track 49 embankment area and the T-Area. The VOC carbon disulfide was detected in seven of eight wells during the Phase II RI. The pesticide 4-4'-dichlorodiphenyltrichloroethene was detected in one well on the southwest corner of the AOC.

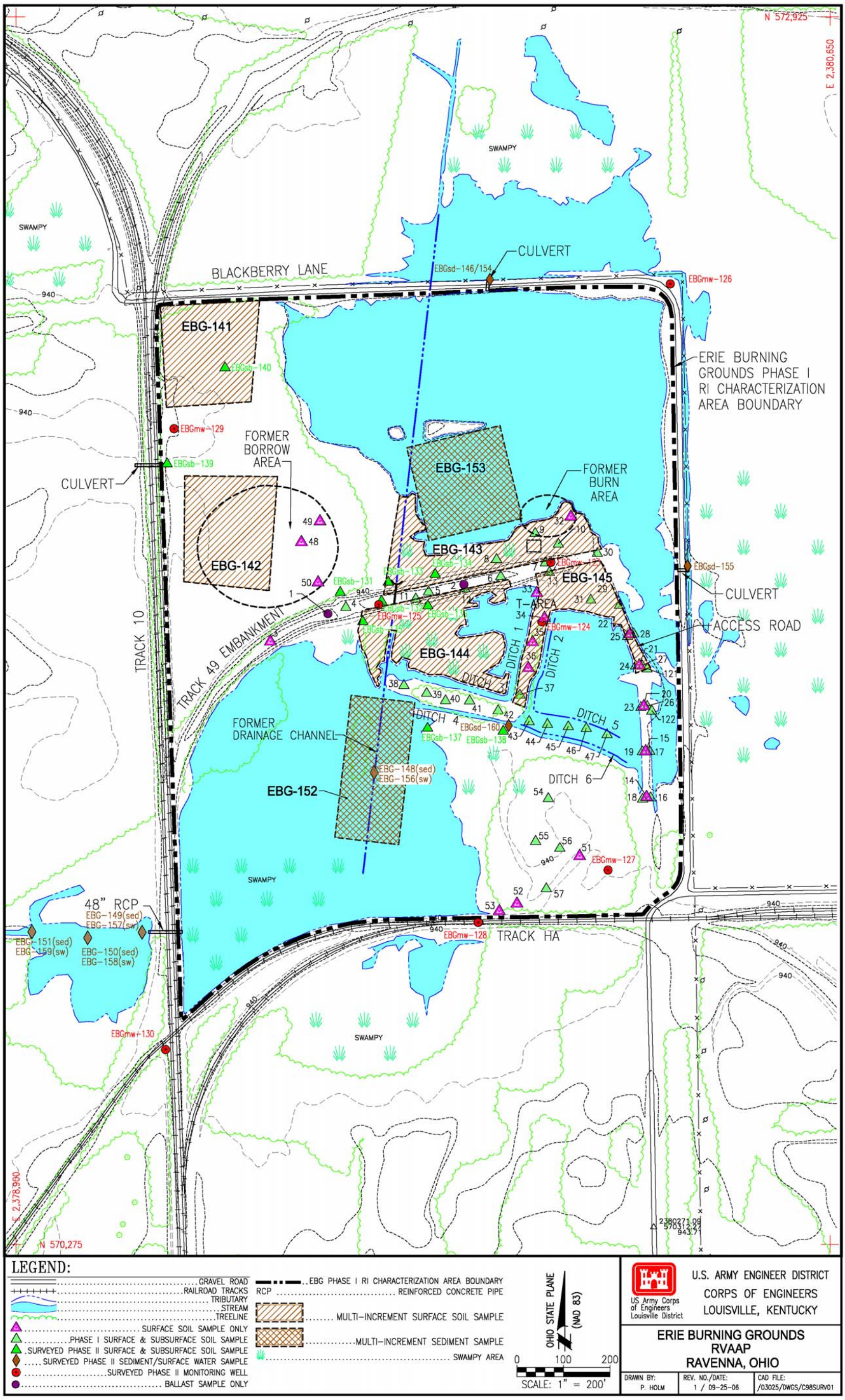

Figure 3-1. Sample and Monitoring Well Locations at EBG

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4.0 CONTAMINANT FATE AND TRANSPORT

Impacted soils at EBG are evaluated to ensure residual concentrations in soils are protective of groundwater at EBG (residential land use scenario) and at an exposure point downgradient of EBG (representative land use scenario). Contaminant fate and transport modeling performed as part of the Phase II RI included leachate modeling [Seasonal Soil Compartment Model (SESOIL)] of constituents in Track 49 embankment soil to the water table. Groundwater modeling (Analytical Transient 1-,2-,3-Dimensional [AT123D]) was conducted from the source to the nearest downgradient receptor (south surface water basin).

Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) and arsenic were identified as final contaminant migration chemicals of potential concern (CMCOPCs) for EBG based on source loading predicted by the SESOIL modeling. These two constituents were also identified as final contaminant migration chemicals of concern (CMCOCs) based on AT123D modeling. The maximum groundwater concentrations of these constituents were predicted to exceed maximum contaminant levels (MCLs) or risk-based concentrations (RBCs) at a downgradient receptor within the model time frame of 1,000 years.

This chapter presents refinements made to the contaminant fate and transport analysis presented in Chapter 5 of the Phase II RI Report for EBG. Section 4.1 identifies and evaluates soil constituents with potential impact to groundwater. Section 4.2 presents the conclusions of the evaluation.

4.1 EVALUATION

This section describes the steps implemented to identify constituents in soils impacting groundwater:

- Section 4.1.1 lists constituents identified in the Phase II RI Report as potentially impacting groundwater.

- Section 4.1.2 evaluates these constituents across multiple media to further refine the list of potential constituents.

- Section 4.1.3 presents refinements to the modeling performed in the Phase II RI Report.

4.1.1 RI Constituent Evaluation Process

Constituents are identified in Chapter 5 (Contaminant Fate and Transport) of the EBG Phase II RI Report (USACE 2005c) that potentially impact groundwater. The RI Report identified potential impacts beneath the source and at receptor locations downgradient of the source.

The RI Report identified constituents with potential or observed impacts beneath a source area as CMCOPCs. Potential impacts beneath the source were determined from model predictions of observed soil sample results where the predicted concentration at the water table beneath the source exceeded the

MCL or Region 9 preliminary remediation goal (PRG). Constituents also are identified as CMCOPCs if they were detected in AOC groundwater and exceeded the MCL or Region 9 PRG.

The RI Report identified constituents with potential groundwater impacts at receptor locations downgradient of the source area as CMCOCs. Potential impacts to receptors downgradient of the AOC source were determined in the RI Report based on modeling of contaminant migration (i.e., CMCOPC migration) within the groundwater aquifer. All CMCOPCs were evaluated for impacts at downgradient receptors.

4.1.2 AOC-Specific Evaluation

The constituents identified in Table 4-1 are evaluated across multiple media. The evaluation examines characteristics of the constituents detected, distribution in soils or water compared to background concentrations, and the nature of modeling completed during the RI (e.g., using a constant source of contamination and no degradation of contaminants). The criteria below were evaluated to determine the potential for impacts to groundwater from impacted soils at EBG.

Table 4-1. Potential Groundwater Impacts Identified in Phase II RI for EBG

Potential Groundwater Impact Beneath the Source[a]	Potential Groundwater Impact Downgradient of the Source[b]
EBG	
Arsenic	Arsenic
RDX	RDX

[a]Potential groundwater impact beneath the source is determined from SESOIL+AT123D modeling in the RI of the concentration at the water table.
[b]Potential groundwater impact downgradient of the source is determined from AT123D modeling of the contaminant plume migrating to receptors.
AT123D = Analytical 1-,2-,3-Dimenional.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RI = Remedial Investigation.
SESOIL = Seasonal Soil Compartment Model.

Background: If model input source concentrations are less than either surface soil (0-1 ft BGS) or subsurface soil (1-3 ft BGS) background, predicted results are compared to the observed groundwater data to assess the nature of the modeling, which assumes a constant source of contamination and no degradation of contaminants. As part of this evaluation, the soils data are reviewed for patterns of detections (both vertically and laterally) and nearby surface water and groundwater results are also reviewed to ensure consistency between predicted and observed results when source concentrations from the RI were at or below background:

- For CMCOPCs where all observed sample results are less than background (either surface or subsurface soils), the constituent is removed from further consideration of future groundwater impacts.

- For CMCOPCs where the source concentration (i.e., concentration input to modeling) is less than background levels (either surface or subsurface soils), the constituent is removed from further consideration of future groundwater impacts.

- For CMCOPCs where one or more samples or the source concentration exceeds background levels, RI data are further reviewed for patter of detection (e.g., proximity and/or patterns of samples with high concentrations, indications of a contaminant plume, etc.).

Predicted Time of Maximum Impact: If the predicted time of maximum impact (as stated in the RI) has likely occurred in the past, groundwater data is reviewed. If maximum groundwater concentrations are less than the constituent-specific MCL or RBC, the constituent is removed from further consideration of future groundwater impacts. If predicted maximum impact is less than the constituent-specific MCL or RBC, then the constituent is removed from further consideration of future groundwater impacts.

Detected in Groundwater: A soil constituent is considered to have no negative impact to groundwater if the constituent is detected in groundwater but 1) not detected in soils, or 2) the soil concentration is equal to or below facility-wide background levels.

Based on the results of the Phase II RI for EBG, two constituents are evaluated for potential impacts in groundwater beneath the source and both constituents also are evaluated for potential impacts to groundwater at downgradient receptors (Table 4-1). Upon further analysis, neither of these constituents were predicted or identified to impact groundwater at the AOC or downgradient of the AOC as summarized below.

- Arsenic: Arsenic is removed from further consideration of future groundwater impacts because concentrations detected in soils are consistent with background concentrations. Modeling results indicate background levels of arsenic in soils may result in groundwater impacts in excess of the MCL.

- RDX: RI SESOIL source load modeling with maximum impact predicted in 4 years. Given AOC history, the maximum impact likely occurred in the past. RDX is removed from further consideration of future groundwater impacts at EBG because there are only two detections in soils, the predicted time of maximum impact to groundwater is 4 years (so maximum impact has likely passed), and RDX has not been detected in surface water or groundwater samples at EBG.

4.1.3 Refined AOC-Specific Modeling Results

Based on the analyses in Section 4.1.2 of the fate and transport assessment performed in support of the Phase II RI for EBG, no constituents of concern (COCs) were identified for further analysis using the SESOIL/AT123D models previously developed.

4.2 CONCLUSIONS

Impacted soils at EBG are not predicted to impact underlying groundwater beneath the AOC. Therefore, soil remediation for protection of groundwater is not required at EBG and the AOC may be released for residential land use with respect to future groundwater impacts from impacted soils.

5.0 HUMAN HEALTH RISK ASSESSMENT

The HHRA at EBG was conducted in the Phase II RI (and summarized in this addendum) to evaluate risks and hazards for two representative receptors (Hunter/Trapper and Fire/Dust Suppression Worker). Three media were evaluated for these two representative receptors: shallow surface soils (0-1 ft BGS), sediments, and surface water. In addition to the representative receptors described above, the other three receptors described in the FWHHRAM [National Guard Trainee, Security Guard/Maintenance Worker, and Resident Subsistence Farmer (adult and child)] were evaluated for exposure to shallow surface soils (0-1 ft BGS), deep surface soils (0-3 ft BGS), subsurface soils (1-3 ft BGS), groundwater, sediments, and surface water. These additional receptors are not anticipated at EBG due to physical constraints (e.g., wetlands and MEC) and intended future land use by OHARNG. The Resident Subsistence Farmer provides a baseline for evaluating EBG with respect to residential release.

No shallow surface soils (0-1 ft BGS) or sediment COCs were identified for either the Hunter/Trapper or the Fire/Dust Suppression Worker at EBG. One metal (arsenic) was identified as a carcinogenic COC for the Fire/Dust Suppression Worker exposed to surface water at EBG. The Hunter/Trapper and Fire/Dust Suppression Worker are not exposed to groundwater.

A summary of the HHRA results is provided in Table 5-1.

Table 5-1. Summary of HHRA Risk Results for Direct Contact at the Erie Burning Ground

Receptor	Total HI	Total ILCR	COCs	Notes
Fire/Dust Suppression Worker (Representative Receptor)				
Shallow Surface Soils[a]	0.0027	2.5E-07	None	Below USEPA and Ohio EPA target risk values for surface soils and sediments.
Sediments	0.0085	2.2E-07	None	
Surface Water	0.098	2.9E-06	As	Exceeds USEPA *de minimis* risk but below Ohio EPA target risk.
Hunter/Trapper (Representative Receptor)				
Shallow Surface Soils[a]	0.00052	6.3E-08	None	Below USEPA and Ohio EPA target risk values for all media.
Sediments	0.0017	5.5E-08	None	
Surface Water	0.023	4.0E-07	None	
Security Guard/Maintenance Worker				
Shallow Surface Soils[a]	0.057	7.5E-06	As, B(*a*)P	Exceeds USEPA *de minimis* risk but below Ohio EPA target risk values
National Guard Trainee				
Deep Surface Soils[a]	2.2	1.6E-05	As, Cr, Mn	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is chromium evaluated as Cr+6.
Sediments	2.2	2.8E-05	As, Cr, Mn	
Surface Water	1.1	1.5E-05	As	Exceeds USEPA and Ohio EPA target risk.
Groundwater	0.29	4.7E-05	As	Exceeds USEPA and Ohio EPA target risk.
Resident Subsistence Farmer (Adult)				
Shallow Surface Soils[a]	0.24	2.3E-05	As, B(*a*)P	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from B(*a*)P and B(*b*)F are below Ohio EPA target risk.
Subsurface Soils[a]	0.14	1.5E-05	As, B(*a*)P	
Sediments	0.88	2.2E-05	As, B(*b*)F	
Surface Water	2.4	8.1E-05	As, Mn	Exceeds USEPA and Ohio EPA target risk.
Groundwater	2.6	5.4E-04	As	Exceeds USEPA and Ohio EPA target risk.

Table 5-1. Summary of HHRA Risk Results for Direct Contact at the Erie Burning Ground (continued)

Receptor	Total HI	Total ILCR	COCs	Notes
Resident Subsistence Farmer (Child)				
Shallow Surface Soils[a]	1.5	2.3E-05	As, B(*a*)P	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from B(*a*)P is below Ohio EPA target risk.
Subsurface Soils[a]	0.88	1.7E-05	As	
Sediments	6.6	2.5E-05	As, Sb	
Surface Water	6.5	6.6E-05	As, Mn	Exceeds USEPA and Ohio EPA target risk.
Groundwater	9.2	3.5E-04	As	Exceeds USEPA and Ohio EPA target risk.

[a]Surface soil is defined as 0-4 ft bgs (deep surface soil) for the National Guard Trainee; however, at EBG, samples were collected to a maximum depth of 3 ft bgs.
Chemical abbreviations:
As = arsenic
B(*b*)F = benzo(*b*)fluoranthene
B(*a*)P = benzo(*a*)pyrene
Cr = chromium (evaluated as hexavalent chromium)
Mn = manganese
Sb = antimony
COC = Constituent of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
Ohio EPA = Ohio Environmental Protection Agency.
USEPA = U. S. Environmental Protection Agency.

5.1 RISK CHARACTERIZATION FOR TRESPASSER SCENARIO

The baseline HHRA provided in the Phase II RI Report for EBG evaluates the potential health risks to humans resulting from exposure to contamination at EBG. The HHRA presented in the Phase II RI Report is based on the methods outlined in the FWHHRAM (USACE 2004), which addresses five receptors to be evaluated at RVAAP [National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer (adult and child)].

In addition to the receptors in the FWHHRAM, an Adult and Juvenile Trespasser is evaluated in this RI Addendum per the FWHHRAM Amendment #1 (USACE 2005b). The Adult and Juvenile Trespasser supplements the baseline HHRA provided in the RI Report to provide risk managers with information relating to potential trespasser exposure. This supplemental risk characterization is presented in Appendix A.

5.2 HUMAN HEALTH PRELIMINARY CLEANUP GOALS

This section documents the proposed land use and corresponding preliminary cleanup goals at EBG. Preliminary cleanup goals are the chemical-specific numeric cleanup goals for protection of human health in the residential or representative land use scenarios.

The HHRA performed for EBG is detailed in the Phase II RI Report. The risk assessment included in the Phase II RI Report documents a variety of potential human receptor populations [e.g., National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper, and Resident Subsistence Farmer (adult and child)] that could be at risk, and identify the COCs that could contribute to potential risks from exposure to contaminated media within EBG. In addition to the receptors in the HHRA, a Trespasser (Adult and Juvenile) is evaluated in Appendix A of this report. The HHRA also documents the calculation of risk-based remedial goal options (RGOs) for

human receptors for all media (i.e., soils, surface water, sediments, and groundwater), all COCs, and all receptor populations evaluated in the RI Report. These risk-based RGOs are referred to as risk-based cleanup goals in this RI Addendum.

Chemical-specific preliminary cleanup goals are established for representative land use (Hunter/Trapper and the Fire/Dust Suppression Worker) and residential land use (Resident Subsistence Farmer) from these risk-based cleanup goals, background concentrations, and other information in this section. Preliminary cleanup goals are established for representative receptors (Hunter/Trapper and the Fire/Dust Suppression Worker) for likely future land use by the OHARNG. In addition to the Hunter/Trapper and Fire/Dust Suppression Worker, preliminary cleanup goals are established for a Resident Subsistence Farmer (adult and child) to provide a baseline for evaluating whether EBG may be eligible for residential release.

The risk-based cleanup goals were calculated using the methodology presented in the Risk Assessment Guidance for Superfund (RAGS), Part B (U. S. Environmental Protection Agency [USEPA] 1991), while incorporating AOC-specific exposure parameters applicable to the five potential receptors outlined in the FWHHRAM. The process for calculating risk-based cleanup goals was a rearrangement of the cancer risk or non-cancer hazard equations, to solve for the concentration that will produce a specific risk or hazard level instead of calculating risk/hazard from a given concentration. For example, the risk-based cleanup goal for RDX at the cancer risk level of 1E-05 for the National Guard Trainee is the concentration of RDX that produces a risk of 1E-05 when using the exposure parameters specific to the National Guard Trainee receptor and the cancer slope factor (CSF) for RDX. Equations, exposure parameters, and toxicity values (CSFs and non-cancer reference doses [RfDs]) are provided in the HHRA and were taken from the FWHHRAM (USACE 2004).

The FWHHRAM (USACE 2004) identifies 1E-05 as a target for cumulative incremental lifetime cancer risk (ILCR) (target risk [TR]) for carcinogens and an acceptable target hazard index (THI) of 1 for non-carcinogens consistent with Ohio EPA guidance (Ohio EPA 2004b), with the caveat that exposure to multiple COCs might require these targets to be decreased for chemical-specific risks. The chemical-specific TR and THI selected for EBG are dependent on several factors, including the number of carcinogenic and non-carcinogenic COCs and the target organs and toxic endpoints of these COCs. For example, if numerous (i.e., more than 10) non-carcinogenic COCs with similar toxic endpoints are present, it may be appropriate to select chemical-specific preliminary cleanup goals with a THI of 0.1 to account for exposure to multiple contaminants. AOC-specific TR and THI levels are established in Section 5.2.3.

The risk-based cleanup goals assumed combined exposure through ingestion, inhalation of vapors and fugitive dust, and dermal contact with contaminated media. For constituents having both a cancer and non-cancer endpoint, risk-based cleanup goals were calculated for both cancer risk and non-cancer hazard at the appropriate TR and THI. The preliminary cleanup goal is selected as the lower of the risk-based cleanup goal for cancer risk and non-cancer hazard and the adult and child receptor (for the Resident Subsistence Farmer), unless the risk-based cleanup goal is below background concentration. If the applicable risk-based cleanup goal concentration is less than background, the background concentration is selected as the preliminary cleanup goal.

The list of human health COCs are identified for EBG based on risk management considerations including:

- Comparison of exposure point concentration (EPC) to preliminary cleanup goal concentrations (including background concentrations);

- Consideration of soils as the primary source of contamination (i.e., if soil concentrations are below background at an AOC, that AOC is not contributing to contamination in other media); and

- Other AOC-specific and receptor-specific considerations.

The remainder of this section provides the following detailed information:

- Land use and potential receptors at EBG (Section 5.2.1);

- A summary of COCs identified in the HHRA (Section 5.2.2);

- Identification of the appropriate TR level and THI for establishing preliminary cleanup goals based on the number and type of COCs identified in the HHRA (Section 5.2.3);

- Chemical-specific preliminary cleanup goals (Section 5.2.4); and

- Risk management considerations and the identification of COCs (Section 5.2.5).

5.2.1 Land Use and Potential Receptors at EBG

EBG may contain MEC and contains environmentally sensitive areas (i.e., wetlands). As a result, this area is managed as Restricted Access. Current plans call for EBG to remain Restricted Access in the future. Restricted Access means this area will not be opened to general training, primarily because of the suspected presence of MEC and the presence of wetlands. EBG is closed to all normal training and administrative activities. Surveying, sampling and other essential security, safety, natural resources management, and other directed activities may be conducted here only after authorized personnel are properly briefed on potential hazards/sensitive areas. Individuals unfamiliar with the hazards/restrictions are escorted by authorized personnel at all times while in the restricted area (USACE 2005c).

Given the restricted access and wetland, EBG may be used in the future by two receptor populations:

- National Guard personnel using surface water for fire or dust suppression.
- Recreational users involved in waterfowl hunting.

These limited activities are compatible with protection of the wetland resource and safety concerns regarding MEC. Hunting is not currently allowed at EBG. Hunters are not allowed at areas that are restricted for environmental reasons (i.e., due to known contamination hazards or during the remedial

investigation process). Hunting at RVAAP is also restricted for reasons other than environmental, including logistics, general safety, security, and military operations. Military and training facility employees are occasionally allowed hunting access to some restricted areas under direct supervision of someone knowledgeable about the site and the security and safety issues associated with it. If hunting is allowed at EBG in the future, hunters will be restricted as they are anywhere at RVAAP. That is, hunters are told where they can and cannot hunt and volunteers are responsible for making sure hunters know the boundaries of their areas and for patrolling the perimeter of hunting areas. All hunters are briefed before they go into the field and told to stay within their assigned areas and to keep vehicles on the roads.

These two receptors (Hunter/Trapper and Fire/Dust Suppression Worker) are evaluated as outlined in Table 5 of the FWHHRAM (USACE 2004). The National Guard Fire/Dust Suppression Worker is assumed to spend 4 hrs/day for 5 days/year for fire suppression (i.e., 20 hrs/year) and 4 hrs/day for 10 days/year (i.e., 40 hrs/year) for dust suppression and is assumed to return to RVAAP and the AOC of interest every year for their entire 25-year enlistment. The Hunter/Trapper is assumed to be onsite for 6 hrs/day for 2 days/year (i.e., 12 hrs/year) and is assumed to hunt at EBG every year that he/she lives in the area (i.e., residential exposure duration of 30 years). Both of these receptors may be exposed to shallow surface soils (0-1 ft BGS), surface water, and sediments. Subsurface soils (1-3 ft BGS) are not evaluated for these receptors because they are not engaged in intrusive activities. The fishery at EBG is very limited because the wetland is so shallow. According to the OHARNG – RTLS, EBG will never be a good fishing pond. It is, however, a very good waterfowl habitat and waterfowl hunting area (Morgan 2004). Thus, because of the surface water habitat characteristics (i.e., shallow with lots of aquatic vegetation), a waterfowl hunter is evaluated, but a fisherman is not.

Exposures to contaminants in shallow surface soils (0-1 ft BGS), surface water, and sediments at EBG are evaluated for incidental ingestion, dermal contact, and inhalation by a National Guard Fire/Dust Suppression Worker and Recreational Hunter/Trapper, and ingestion of waterfowl by the Recreational Hunter/Trapper as defined in Tables 1 and 5 of the FWHHRAM (USACE 2004).

In addition to the representative receptors described above, the other three receptors described in the FWHHRAM [National Guard Trainee, Security Guard/Maintenance Worker, and Resident Subsistence Farmer (adult and child)] are evaluated to provide additional information (e.g., to establish the need for institutional controls), a Trespasser (Adult and Juvenile) scenario is included to provide information for evaluation in the event security protocols change. These additional receptors are not anticipated at EBG due to physical constraints and intended future land use by OHARNG. The National Guard Trainee is not anticipated due to physical constraints (e.g., wetlands, MEC) and OHARNG land use plan, which does not include training in this area. The Resident Subsistence Farmer (adult and child) provides a baseline for evaluating EBG with respect to residential release.

Anticipated use of surface water at EBG includes dust suppression, fire control, trapping, and waterfowl hunting. The Fire/Dust Suppression Worker is used as the representative receptor for the intended land use because exposures to this receptor are higher than exposures for the Hunter/Trapper. The Fire/Dust Suppression Worker is also reasonably protective of a Juvenile Trespasser who is assumed to visit the AOC 2 hrs/day, 50 days/year (100 hrs/year) for 10 years and an Adult Trespasser who is assumed to visit

the AOC 2 hrs/day, 75 days/year (150 hrs/year) for 30 years (compared to 60 hrs/year for 25 years for the Fire/Dust Suppression Worker). Estimated risks to a Trespasser are slightly (approximately 2 to 11 times) higher than the Fire/Dust Suppression Worker; however, the exposure frequencies for the Trespasser are probably larger than what is likely to occur [i.e., the same trespasser is assumed to visit EBG every weekend (Juvenile) or more (Adult) for 10 to 30 years].

In addition to the receptors described above, the Resident Subsistence Farmer (adult and child) provides a baseline for evaluating whether EBG may be eligible for residential release. However, EBG is not currently a candidate for residential release due to MEC concerns and the presence of wetlands; these issues will most likely preclude EBG from residential land use in the future. The Resident Subsistence Farmer is considered a "worst-case" exposure scenario and is considered to be protective for all other potential land uses.

Although not likely, future land use may change from fire/dust suppression to some other type of National Guard activity, and the OHARNG has requested as few restrictions of their activities as possible. Results for the National Guard Trainee are also discussed in this RI Addendum Report since (1) the exposure parameters for the National Guard Trainee are more robust than those for the Fire/Dust Suppression Worker (e.g., exposures for 960 hrs/year for 25 years for the National Guard Trainee compared to 60 hrs/year for 25 years for the Fire/Dust Suppression Worker), and (2) the total ILCR for the National Guard Trainee are slightly above the Ohio EPA's target risk goal of 1.0E-5 and hazard index (HI)=1.0 (see Table 5-1).

5.2.2 Constituents of Concern

COCs are identified in the HHRA as constituents with an ILCR greater than 1E-06 and/or a HI greater than 1 for a given receptor. COCs were identified in the HHRA for each exposure medium and receptor evaluated.

5.2.2.1 COCs in Soils

The wetland at EBG continuously contains water; therefore, the sediments are considered wet and are not included in the scope of this addendum.

The total HI is less than 1.0 and the total ILCR is less than 1E-06 for the Fire/Dust Suppression Worker exposed to contaminants in shallow surface soils (0-1 ft BGS); therefore, no COCs were identified for this receptor.

For the Resident Subsistence Farmer (adult and child); no non-carcinogenic shallow surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil COCs and two carcinogenic shallow surface and subsurface soil COCs were identified including: one metal (arsenic) and one SVOC [benzo(a)pyrene].

A Trespasser (Adult and Juvenile) is evaluated in Appendix A to supplement the representative receptors and residential land use. One soil COC (arsenic) is identified for both the Adult and Juvenile Trespasser.

For the National Guard Trainee exposed to deep surface soils (0-3 ft BGS), one non-carcinogenic COC (manganese) and two carcinogenic COCs (arsenic and chromium, evaluated as hexavalent chromium) were identified.

5.2.2.2 COCs in Surface Water and Sediments

The wetland at EBG continuously contains water; therefore, the wetland is evaluated for both surface water and wet sediments.

One surface water COC (arsenic) was identified for the representative receptor (Fire/Dust Suppression Worker) at EBG.

Two surface water COCs (arsenic and manganese) were identified in the HHRA for the Resident Subsistence Farmer (adult and child).

One surface water COC (arsenic) is identified for both the Adult and Juvenile Trespasser.

For the National Guard Trainee, one surface water COC (arsenic) was identified.

The total HI is less than 1.0 and the total ILCR is less than 1E-06 for the Fire/Dust Suppression Worker exposed to contaminants in sediments; therefore, no COCs were identified for this receptor.
For the Resident Subsistence Farmer (adult and child), one non-carcinogenic sediment COC (antimony) and two carcinogenic sediment COCs were identified including: one metal (arsenic) and one SVOC [benzo(b)fluoranthene].

Arsenic is also identified as a sediment (adult only) COC for the Trespasser.

For the National Guard Trainee exposed to sediments, one non-carcinogenic COC (manganese) and two carcinogenic COCs (arsenic and chromium, evaluated as hexavalent chromium) were identified.

5.2.2.3 COCs in Groundwater

The Fire/Dust Suppression Worker is not exposed to groundwater.

One groundwater COC (arsenic) was identified in the HHRA for the Resident Subsistence Farmer (adult and child).
The Trespasser is not exposed to groundwater.

One groundwater COC (arsenic) was identified in the HHRA for the National Guard Trainee.

5.2.3 Target Risk for Preliminary Cleanup Goals

The FWHHRAM (USACE 2004) identifies a 1E-05 target for ILCR (TR) for carcinogens and an acceptable THI of 1 for non-carcinogens consistent with Ohio EPA guidance, with the caveat that exposure to multiple COCs might require these targets to be decreased. For example, if numerous (i.e., more than 10) non-carcinogenic or carcinogenic COCs with similar toxic endpoints are present, it might be appropriate to select chemical-specific preliminary cleanup goals with a TR of 1E-06 or a THI of 0.1 to account for exposure to multiple contaminants. The TR and THI selected for EBG are dependent on several factors, including the number of carcinogenic and non-carcinogenic COCs and the target organs and toxic endpoints of these COCs. A chemical-specific TR of 1E-05 and THI of 1.0 are identified as appropriate for establishing preliminary cleanup goals for soils at EBG based on the small number of COCs present and the types of COCs (carcinogenic or non-carcinogenic) as summarized below.

The Fire/Dust Suppression Worker is the representative receptor for EBG. No soil/sediment COCs were identified for this receptor. Two soil COCs [arsenic and benzo(a)pyrene)] were identified for the Resident Subsistence Farmer. One soil COC (arsenic) was identified for the Trespasser and three soil COCs (arsenic, chromium, and manganese) were identified for the National Guard Trainee. Carcinogenic COCs across these receptors included arsenic, chromium (as hexavalent chromium), and benzo(a)pyrene; non-carcinogenic COCs across these receptors included arsenic, chromium, and manganese. Of these three carcinogenic COCs, one (arsenic) potentially produces respiratory system tumors, one (chromium) produces lung tumors, and the other [benzo(a)pyrene] is associated with stomach tumors. Critical effects for the three non-carcinogenic COCs include skin/vascular effects (arsenic), liver effects (chromium), and central nervous system effects (manganese). Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 were identified as appropriate for establishing preliminary cleanup goals for soils at EBG.

Three sediment COCs were identified for the Resident Subsistence Farmer; one sediment COC was identified for the Trespasser; and three sediment COCs were identified for the National Guard Trainee. Carcinogenic COCs across these receptors included arsenic, chromium (as hexavalent chromium), and benzo(b)fluoranthene; non-carcinogenic COCs across these receptors included antimony, arsenic, chromium, and manganese. Of the three carcinogenic COCs, one (arsenic) potentially produces respiratory system tumors, one (chromium) produces lung tumors, and the other [benzo(b)fluoranthene] is associated with stomach tumors. Critical effects for the four non-carcinogenic COCs include gastrointestinal, liver, cardiovascular, and developmental toxicity (antimony); skin/vascular effects (arsenic); liver effects (chromium); and central nervous system effects (manganese). Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 were identified as appropriate for establishing preliminary cleanup goals for sediments at EBG.

Only two surface water COCs (arsenic and manganese) and one groundwater COC (arsenic) were identified at EBG; therefore, a chemical-specific TR of 1E-05 and THI of 1.0 were also identified as appropriate for establishing preliminary cleanup goals for these media at EBG.

5.2.4 Preliminary Cleanup Goals

5.2.4.1 Soil Preliminary Cleanup Goals

No soil COCs were identified for the Fire/Dust Suppression Worker; therefore, no preliminary cleanup goals are identified for this receptor.

Risk-based cleanup goals calculated in the HHRA for COCs in soils, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Table 5-2.

Table 5-2. Soil Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at EBG

	EPC (mg/kg)		Risk-Based Cleanup Goal from HHRA (mg/kg)				Background (mg/kg)		Preliminary Cleanup Goal (mg/kg)	
			Adult		Child					
COC	Surface[a]	Subsurface[a]	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05	Surface	Subsurface	Surface[a]	Subsurface[a]
Inorganics										
Arsenic	11	9.3	130	6.7	22	5.7	15	20	15	20
Semivolatiles										
Benzo(a)pyrene	0.32	0.068	--	0.59	--	0.97	NA	NA	0.59	0.59

[a] Shallow (0-1 ft below ground surface [BGS]) surface soils and subsurface (1-3 ft BGS) soils are used for Resident Subsistence Farmer.
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
HHRA = Human health risk assessment.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background concentrations are used for inorganic COCs only.

Estimated EPCs of arsenic and benzo(a)pyrene are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario.

Risk-based cleanup goals calculated in the HHRA for COCs in soils, background concentrations for inorganics, and preliminary cleanup goals for the National Guard Trainee are presented in Table 5-3.

Table 5-3. Soil Preliminary Cleanup Goals for National Guard Trainee Scenario at EBG

COC	EPC (mg/kg)	Risk-Based Cleanup Goal from HHRA (mg/kg)		Background[a] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	9.6	1500	31	15.4	31
Chromium	19.8	670	16	17.4	17.4
Manganese	600	350	--	1450	1800[b]

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
[b]Value is U. S. Environmental Protection Agency Region 9 residential preliminary remediation goal (PRG) (http://www.epa.gov/region09/waste/ sfund/prg/index.html).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HHRA = Human health risk assessment.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

Estimated EPCs of arsenic and manganese are less than the preliminary cleanup goals for these COCs for the National Guard Trainee Scenario.

5.2.4.2 Surface Water and Sediment Preliminary Cleanup Goals

Risk-based cleanup goals calculated in the HHRA for COCs in surface water, background concentrations for inorganics, and preliminary cleanup goals for the Fire/Dust Suppression Worker are presented in Table 5-4.

Table 5-4. Surface Water Preliminary Cleanup Goals for Fire/Dust Suppression Worker at EBG

COC	EPC (mg/L)	Risk-Based Cleanup Goal from HHRA (mg/L)		Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	0.072	4.1	0.25	0.0032	0.25

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
COC = Constituent of concern.
EPC = Exposure point concentration.
HHRA = Human health risk assessment.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

The EPC for arsenic in surface water is less than the preliminary cleanup goal for this metal for the Fire/Dust Suppression Worker.

Risk-based cleanup goals calculated in the HHRA for COCs in surface water, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Table 5-5.

Table 5-5. Surface Water Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at EBG

COC	EPC (mg/L)	Risk-Based Cleanup Goal from HHRA (mg/L)				Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
		Adult		Child			
		HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics							
Arsenic	0.072	0.17	0.0089	0.042	0.011	0.0032	0.0089
Manganese	9.9	6.0	--	2.6	--	0.39	2.6

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HHRA = Human health risk assessment.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

Risk-based cleanup goals calculated in the HHRA for COCs in surface water, background concentrations for inorganics, and preliminary cleanup goals for the National Guard Trainee are presented in Table 5-6.

Table 5-6. Surface Water Preliminary Cleanup Goals for National Guard Trainee Scenario at EBG

COC	EPC (mg/L)	Risk-Based Cleanup Goal from HHRA (mg/L)		Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	0.072	0.78	0.048	0.032	0.048

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
COC = Constituent of concern.
EPC = Exposure point concentration.
HHRA = Human health risk assessment.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

No sediment COCs were identified for the Fire/Dust Suppression Worker; therefore, no preliminary cleanup goals are identified for this receptor.

Risk-based cleanup goals calculated in the HHRA for COCs in sediments, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Table 5-7.

Table 5-7. Sediment Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at EBG

COC	EPC (mg/kg)	Risk-Based Cleanup Goal from HHRA (mg/kg)				Background[a] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
		Adult		Child			
		HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics							
Arsenic	14	130	6.7	22	5.7	19.5	20
Antimony	160	250	--	31	--	0[b]	31
Semivolatiles							
Benzo(b)fluoranthene	0.64	--	5.9	--	9.7	NA	5.9

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).

[b]Antimony was not detected in background sediment samples; therefore, background criterion is set to 0 mg/kg.

-- = Toxic endpoint not evaluated for this COC.

COC = Constituent of concern.

EPC = Exposure point concentration.

HHRA = Human health risk assessment.

HI = Hazard index.

ILCR = Incremental lifetime cancer risk.

NA = Not applicable. Background concentrations are used for inorganic COCs only.

Estimated EPCs for arsenic and benzo(b)fluoranthene in sediments are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario.

Risk-based cleanup goals calculated in the HHRA for COCs in sediments, background concentrations for inorganics, and preliminary cleanup goals for the National Guard Trainee are presented in Table 5-8.

Table 5-8. Sediment Preliminary Cleanup Goals for National Guard Trainee Scenario at EBG

COC	EPC (mg/kg)	Risk-Based Cleanup Goal from HHRA (mg/kg)		Background[a] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	14	1500	31	19.5	31
Chromium	38.4	670	16	18	18
Manganese	562	350	--	1950	1950

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).

-- = Toxic endpoint not evaluated for this COC.

COC = Constituent of concern.

EPC = Exposure point concentration.

HHRA = Human health risk assessment.

HI = Hazard index.

ILCR = Incremental lifetime cancer risk.

Estimated EPCs for arsenic and manganese in sediments are less than the preliminary cleanup goals for these COCs for the National Guard Trainee Scenario.

5.2.4.3 Groundwater Preliminary Cleanup Goals

Risk-based cleanup goals calculated in the HHRA for COCs in groundwater, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Table 5-9.

Table 5-9. Groundwater Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at EBG

COC	EPC (mg/L)	Risk-Based Cleanup Goal from HHRA (mg/L)				Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
		Adult		Child			
		HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics							
Arsenic	0.029	0.011	0.00057	0.0031	0.00081	0.012	0.012

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). A value of 0 is used for metals not detected.
COC = Constituent of concern.
EPC = Exposure point concentration.
HHRA = Human health risk assessment.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

Risk-based cleanup goals calculated in the HHRA for COCs in groundwater, background concentrations for inorganics, and preliminary cleanup goals for the National Guard Trainee are presented in Table 5-10.

Table 5-10. Groundwater Preliminary Cleanup Goals for National Guard Trainee Scenario at EBG

COC	EPC (mg/L)	Risk-Based Cleanup Goal from HHRA (mg/L)		Background[a] (mg/L)	Preliminary Cleanup Goal (mg/L)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	0.029	0.098	0.0061	0.012	0.012

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
COC = Constituent of concern.
EPC = Exposure point concentration.
HHRA = Human health risk assessment.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

5.2.5 Risk Management Considerations

5.2.5.1 Soils

No soil COCs were identified for the Fire/Dust Suppression Worker in the HHRA.

Two soil COCs [arsenic and benzo(a)pyrene] were identified in the HHRA for the Resident Subsistence Farmer. Neither of these COCs are identified for evaluation in an FS for Resident Subsistence Farmer land use for the following reasons:

- The EPC for arsenic in shallow surface (0-1 ft BGS) is less than the preliminary cleanup goal for this chemical for the Resident Subsistence Farmer Scenario (Table 5-11). Furthermore, seven of 69 soil samples exceeded the background value for arsenic and the preliminary cleanup goal for the Resident Subsistence Farmer. These seven samples are scattered throughout EBG and are surrounded by sample locations that had arsenic concentrations below background values. Also, it is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period (e.g., 24 hrs/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

- The EPC for benzo(a)pyrene in shallow surface (0-1 ft BGS) is less than the preliminary cleanup goal for this chemical for the Resident Subsistence Farmer Scenario (Table 5-11). Only one individual benzo(a)pyrene concentration (out of 66 total sample results) exceeded the preliminary cleanup goal for the Resident Subsistence Farmer; as mentioned above, it is unlikely that a resident would be exposed to concentrations at this individual location over the entire exposure period.

- The EPCs and all individual subsurface soil (1-3 ft BGS) concentrations were below the preliminary cleanup goals for arsenic and benzo(a)pyrene for the Resident Subsistence Farmer Scenario (Table 5-11).

Three deep surface soil (0-3 ft BGS) COCs (arsenic, chromium, and manganese) were identified in the HHRA for the National Guard Trainee. Because the EPC for chromium is above its background and preliminary cleanup goal, this chemical would be identified for evaluation in an FS if the National Guard Trainee land use were a viable option at EBG (it is not a viable option). The other two COCs are not identified for evaluation in an FS for National Guard Trainee land use for the following reasons:

- The EPC for arsenic in deep surface (0-3 ft BGS) is less than the preliminary cleanup goal for this constituent for the National Guard Trainee Scenario (Table 5-12). Furthermore, no individual arsenic concentrations (out of 111 total sample results) exceeded the preliminary cleanup goal for the National Guard Trainee. Also, it is unlikely that a National Guard Trainee would be exposed to concentrations at individual locations over the entire exposure period (e.g., 960 hrs/year for 25 years).

- The EPC for manganese in deep surface (0-3 ft BGS) is less than the preliminary cleanup goal for this constituent for the National Guard Trainee Scenario (Table 5-12). Furthermore, three individual manganese concentrations (out of 111 total sample results) exceeded the preliminary cleanup goal for the National Guard Trainee, with these samples scattered throughout EBG. As mentioned above, it is unlikely that a National Guard Trainee would be exposed to concentrations at individual locations over the entire exposure period.

5.2.5.2 Sediments and Surface Water

No sediment COCs were identified for the Fire/Dust Suppression Worker in the HHRA; therefore, no COCs are identified for evaluation in an FS for this representative receptor.

Three wet sediment COCs [antimony, arsenic, and benzo(b)fluoranthene] were identified for a Resident Subsistent Farmer in the HHRA. Antimony is identified as a COC for evaluation in an FS for Resident Subsistent Farmer land use. Arsenic and benzo(b)fluoranthene are not identified as COCs for evaluation in an FS for Resident Subsistent Farmer land use because the EPCs for these constituents in sediments are less than the preliminary cleanup goals for the Resident Subsistence Farmer Scenario (Table 5-11).

Three wet sediment COCs (arsenic, chromium, and manganese) were identified for a National Guard Trainee in the HHRA. Chromium would be identified as a COC for evaluation in an FS if the National Guard Trainee land use were a viable option at EBG (it is not). Arsenic and manganese are not identified as COCs for evaluation in an FS for National Guard Trainee land use because the EPCs for these constituents in sediments are less than the preliminary cleanup goals for the National Guard Trainee Scenario (Table 5-12).

No surface water COCs are identified for evaluation in an FS for Fire/Dust Suppression Worker, Resident Subsistence Farmer, or National Guard Trainee land use because arsenic and manganese generally are not present above background in the surrounding soils or underlying sediments indicating no AOC-related source to the surface water (Table 5-13).

5.2.5.3 Groundwater

No groundwater COCs are identified for evaluation in an FS for the Fire/Dust Suppression Worker because this receptor is not exposed to groundwater.

No groundwater COCs are identified for evaluation in an FS for Resident Subsistence Farmer or National Guard Trainee land use because, while the EPC for arsenic exceeds the preliminary cleanup goals established for the Resident Subsistence Farmer and the National Guard Trainee (Table 5-13), the average concentration does not. Detected concentrations of arsenic are similar to background in the overlying soils/sediments indicating no AOC-related source to the groundwater.

Table 5-11. Soil and Sediment COCs for Resident Subsistence Farmer Land Use at EBG

COC[a]	Freq. of Detect	Measured Concentration (mg/kg)			Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
		Avg.	Max[b]	EPC[c]						
Shallow Surface Soils (0-1 ft BGS)										
Arsenic	69/69	9.2	26	11	15	7	15	7	EPC less than background/preliminary cleanup goal	NC
Benzo(*a*)pyrene	12/66	0.26	1.8	0.32	NA	NA	0.59	1	EPC less than preliminary cleanup goal	NC
Subsurface Soils (1-3 ft BGS)										
Arsenic	42/42	8.1	19	9.3	19.5	0	19.5	0	EPC less than background/preliminary cleanup goal	NC
Benzo(*a*)pyrene	3/42	0.21	0.068	0.068	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC
Sediments										
Antimony	31/92	87	3160	156	0	31	31	11	Exceeds background and preliminary cleanup goal in soils/sediments	FSCOC
Arsenic	92/92	12	119	14	19.5	10	20	10	EPC less than background/preliminary cleanup goal	NC
Benzo(*b*)fluoranthene	9/92	0.54	0.70	0.64	NA	NA	5.9	0	All detects less than preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the Human Health Risk Assessment (HHRA).

[b]Maximum detected concentration.

[c]Exposure point concentration (EPC) is 95 % upper confidence limit (UCL_{95}) of the mean or maximum detected concentration depending on number of samples and data distribution.

[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). Constituents not detected in background are assigned a value of 0.

[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. Figure 3-1 displays all of these soil and sediment locations.

For shallow surface soils, seven locations had arsenic detected at concentrations above its preliminary cleanup goal of 15 mg/kg: EBG-014 (15.7 mg/kg); EBG-032 (16.5 mg/kg); EBG-041 (16.8 mg/kg); EBG-136 (17.5 mg/kg); EBG-131 (19.7 mg/kg); EBG-008 (24.1 mg/kg); and EBG-134 (25.6 mg/kg).

One shallow surface soil sample (EBG-003) had benzo(a)pyrene detected (1.8 mg/kg) above its preliminary cleanup goal of 0.59 mg/kg.

For sediments 11 locations had antimony detected at concentrations above its preliminary cleanup goal of 20 mg/kg: EBG-077 (33.3 mg/kg); EBG-079 (95.6 mg/kg); EBG-060 (161 mg/kg); EBG-079 (181 mg/kg); EBG-104 (207 mg/kg); EBG-060 (323 mg/kg); EBG-059 (363 mg/kg); EBG-079 (440 mg/kg); EBG-059 (451 mg/kg); EBG-080 (2090 mg/kg); and EBG-082 (3160 mg/kg).

For sediments 10 locations had arsenic detected at concentrations above its preliminary cleanup goal of 20 mg/kg: EBG-071 (19.8 mg/kg); EBG-099 (20 mg/kg); and EBG-116 (19.9 mg/kg); EBG-068 (20.4 mg/kg); EBG-059 (21.8 mg/kg); EBG-059 (22.2 mg/kg); EBG-077 (26.3 mg/kg); EBG-070 (27.4 mg/kg); EBG-061 (32.3 mg/kg); and EBG-117 (119 mg/kg).

[f]Preliminary cleanup goals from Table 5-2 and 5-7.

[g]Recommendation for COCs for evaluation in a Feasibility Study (FS).

Detects = Detectable concentrations.

FSCOC = COC for evaluation in an FS.

NA = Not applicable. Background criteria are used only for naturally occurring inorganic constituents.

NC = Not recommended as a COC for evaluation in a FS.

Table 5-12. Soil and Sediment COCs for National Guard Trainee Land Use at EBG

COC[a]	Freq. of Detect	Measured Concentration (mg/kg)			Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
		Avg.	Max[b]	EPC[c]						
Deep Surface Soils (0-3 ft BGS)										
Arsenic	111/111	8.8	25.6	9.6	15.4	9	31	0	EPC less than background/preliminary cleanup goal	NC
Chromium	111/111	17.4	102	19.8	17.4	34	17.4	34	EPC greater than background/preliminary cleanup goal	FSCOC
Manganese	111/111	510	3820	600	1450	10	1800	3	EPC less than background/preliminary cleanup goal	NC

Table 5-12. Soil and Sediment COCs for National Guard Trainee Land Use at EBG (continued)

COC[a]	Freq. of Detect	Measured Concentration (mg/kg)			Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
		Avg.	Max[b]	EPC[c]						
Sediments										
Arsenic	92/92	11.8	119	14	20	7	31	2	EPC less than background/preliminary cleanup goal	NC
Chromium	90/90	31	253	38.4	18.1	47	18.1	47	EPC greater than background/preliminary cleanup goal	FSCOC
Manganese	92/92	420	7390	562	1950	3	1950	3	EPC less than background/preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the Human Health Risk Assessment (HHRA).

[b]Maximum detected concentration.

[c]Exposure point concentration (EPC) is 95 % upper confidence limit (UCL_{95}) of the mean or maximum detected concentration depending on number of samples and data distribution.

[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).

[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. Figure 3-1 displays all of these soil and sediment locations.

For deep surface soil, no locations had arsenic detected at concentrations above its preliminary cleanup goal of 31 mg/kg.

For deep surface soil, 34 locations had chromium detected at concentrations above its preliminary cleanup goal of 17.4 mg/kg: EBG-007 (17.5 mg/kg); EBG-046 (17.7 mg/kg); EBG-010 (17.8 mg/kg); EBG-44 (18.1 mg/kg); EBG-017 (18.1 mg/kg); EBG-013 (18.3 mg/kg); EBG-012 (18.5 mg/kg). EBG-002 (18.7 mg/kg); EBG-003 (18.7 mg/kg); EBG-019 (18.9 mg/kg); EBG-031 (19.1 mg/kg); EBG-011 (19.4 mg/kg); EBG-007 (19.7 mg/kg); EBG-047 (20.1 mg/kg); EBG- 045 (20.8 mg/kg); EBG-132 (21.6 mg/kg); EBG-139 (22.4 mg/kg); EBG-047 (22.7 mg/kg); EBG-026 (22.7 mg/kg); EBG-024 (23.2 mg/kg); EBG-043 (24.7 mg/kg); EBG-031 (25 mg/kg); EBG-008 (26 mg/kg); EBG-045 (26.5 mg/kg); EBG-010 (27.2 mg/kg); EBG-011 (32.3 mg/kg); EBG-131 (32.8 mg/kg); EBG-034 (34.1 mg/kg); EBG-133 (43.4 mg/kg); EBG-135(45.3 mg/kg); EBG-033 (52.8 mg/kg); EBG-136 (85.4 mg/kg); EBG-008 (87.9 mg/kg); and EBG-134 (102 mg/kg).

For deep surface soil, 3 locations had manganese detected at concentrations above its preliminary cleanup goal of 1950 mg/kg: EBG-027 (1960 mg/kg); EBG-022 (2320 mg/kg); and EBG-001 (3820 mg/kg).

For sediments 2 locations had arsenic detected at concentrations above its preliminary cleanup goal of 31 mg/kg: EBG-061 (32.3 mg/kg) and EBG-117 (119 mg/kg).

For sediments 47 locations had chromium detected at concentrations above its preliminary cleanup goal of 18.1 mg/kg: EBG-118 (18.5 mg/kg), EBG-073 (18.6 mg/kg), EBG-066 (18.8 mg/kg), EBG-064 (18.8 mg/kg), EBG-096 (19.1 mg/kg), EBG-066 (19.1 mg/kg), EBG-064 (19.2 mg/kg), EBG-100 (19.3 mg/kg), EBG-092 (19.9 mg/kg), EBG-097 (20.2 mg/kg), EBG-064 (20.5 mg/kg), EBG-093 (20.9 mg/kg), EBG-108 (21.1 mg/kg), EBG-091 (21.7 mg/kg), EBG-068 (21.9 mg/kg), EBG-105 (22.2 mg/kg), EBG-075 (22.3 mg/kg), EBG-109 (24.3 mg/kg), EBG-148 (24.3 mg/kg), EBG-101 (24.6 mg/kg), EBG-075 (24.8 mg/kg), EBG-058 (27 mg/kg), EBG-062 (27.7 mg/kg), EBG-061 (27.8 mg/kg), EBG-058 (28 mg/kg), EBG-070 (31.5 mg/kg), EBG-098 (33 mg/kg), EBG-074 (35.2 mg/kg), EBG-070 (38.6 mg/kg), EBG-077 (38.9 mg/kg), EBG-063 (43.5 mg/kg), EBG-106 (43.8 mg/kg), EBG-063 (45.1 mg/kg), EBG-104 (50.7 mg/kg), EBG-080 (50.7 mg/kg), EBG-112 (51.8 mg/kg), EBG-060 (54.9 mg/kg), EBG-079 (58 mg/kg), EBG-070 (67.3 mg/kg), EBG-061 (70.8 mg/kg), EBG-060 (74.1 mg/kg), EBG-079 (78.2 mg/kg), EBG-062 (95.2 mg/kg), EBG-059 (145 mg/kg), EBG-079 (159 mg/kg), EBG-059 (217 mg/kg), and EBG-082 (253 mg/kg).

For sediments 3 locations had manganese detected at concentrations above its preliminary cleanup goal of 1950 mg/kg: EBG-115 (2070 mg/kg); EBG-079 (2120 mg/kg); and EBG-059 (7390 mg/kg).

[f]Preliminary cleanup goal from Tables 5-3 and 5-8.

[g]Recommendation for COCs for evaluation in a Feasibility Study (FS).

Detects = detectable concentrations

FSCOC = COC for evaluation in an FS.

NA = not applicable. Background criteria are used only for naturally occurring inorganic constituents.

NC = not recommended as a COC for evaluation in a FS.

Table 5-13. Surface Water and Groundwater COCs for Fire/Dust Suppression Worker, Resident Subsistence Farmer, and National Guard Trainee Land Use at EBG

COC[a]	Freq. of Detect	Measured Concentration (mg/L)			Bkg[d] (mg/L)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/L)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
		Avg.	Max[b]	EPC[c]						
Surface Water – Representative Receptor (Fire/Dust Suppression Worker)										
Arsenic	26/ 26	0.019	0.12	0.072	0.0032	18	0.25	0	EPC and all detects less than preliminary cleanup goal	NC
Surface Water – Resident Subsistence Farmer										
Arsenic	26/ 26	0.019	0.12	0.072	0.0032	18	0.0089	11	No AOC-related source from soils	NC
Manganese	25/ 26	2.4	11	9.9	0.39	16	2.6	7	No AOC-related source from soils	NC
Surface Water – National Guard Trainee										
Arsenic	26/ 26	0.019	0.12	0.072	0.0032	18	0.048	2	No AOC-related source from soils	NC
Groundwater– Resident Subsistence Farmer										
Arsenic	8/ 8	0.011	0.029	0.029	0.012	3	0.012	3	No AOC-related source from soils	NC
Groundwater – National Guard Trainee										
Arsenic	8/ 8	0.011	0.029	0.029	0.012	3	0.012	3	No AOC-related source from soils	NC

[a]Constituent of concern (COC) identified in the Human Health Risk Assessment (HHRA).

[b]Maximum detected concentration.

[c]Exposure point concentration (EPC) is 95 % upper confidence limit (UCL_{95}) of the mean or maximum detected concentration depending on number of samples and data distribution.

[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).

[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal.

[f]Preliminary cleanup goal from Tables 5-4, 5-5, 5-6, 5-9, and 5-10.

[g]Recommendation for COCs for evaluation in a Feasibility Study (FS).

AOC = Area of concern.

Detects = detectable concentrations

NA = not applicable. Background criteria are used only for naturally occurring inorganic constituents.

NC = not recommended as a COC for evaluation in a FS.

5.2.5.4 Summary of COCs for Further Evaluation

A summary of the COCs and preliminary cleanup goals for the COCs identified for further evaluation is provided below in Table 5-14 for the Fire/Dust Suppression Worker, Resident Subsistence Farmer, and National Guard Trainee land use.

Table 5-14. Summary of COCs and Preliminary Cleanup Goals for EBG

COC	Soil Preliminary Cleanup Goal (mg/kg)	Sediment[a] Preliminary Cleanup Goal (mg/kg)	Surface Water Preliminary Cleanup Goal (mg/L)	Groundwater Preliminary Cleanup Goal (mg/L)
Representative Land Use (Restricted Access – Fire/Dust Suppression Worker)				
None	--	--	--	--
Residential Land Use (Resident Subsistence Farmer)				
Antimony	--	31	--	--
National Guard Trainee Land Use[b]				
Chromium	17.4	18	--	--

[a]Sediments at EBG are wet.

[b]For information only; National Guard Trainee land use is not the future land use for EBG.

-- = Constituent is not a COC for this medium.
COC = Constituent of concern.

6.0 ECOLOGICAL RISK ASSESSMENT

EBG contains sufficient terrestrial and aquatic (soils, sediments, and surface water) habitat to support various classes of ecological receptors. The presence of suitable habitat and observed receptors at the AOC warranted a screening ecological risk assessment (SERA). The Ohio EPA protocol (Level I) was met and Level II was needed. The RVAAP Facility-Wide Ecological Risk Work Plan (USACE 2003a) was used to guide the work.

The SERA process provides an evaluation of the potential for risk to ecological receptors. This evaluation is considered to be conservative for two reasons: (1) maximum detected concentrations (MDCs) are compared to ecological screening values (ESVs) as opposed to EPCs being compared to these values; and (2) the medium-specific ESVs are intended to protect sensitive, multiple receptors, some of which may not be present at EBG. Constituents with no ESV are also retained as constituents of potential ecological concern (COPECs). As part of this screen, all constituents classified as persistent, bioaccumulative, and toxic (PBT) are retained as COPECs. For the Level II Screen, specific receptors are not identified because the ESVs are screening toxicity benchmarks that are intended to protect sensitive, multiple receptors (and thus, are conservative in nature).

The Baseline Ecological Risk Assessment (BERA) continues the SERA process. The focus of the assessment is on soils, sediments, and surface water and on specific ecological receptors (e.g., mammals, birds, and aquatic organisms). Its input constituents are COPECs and the BERA process produces constituents of ecological concern (COECs). COECs are identified as constituents having a hazard quotient (HQ) > 1.0 for one or more of the ecological receptors that were evaluated in the BERA and constituents for which there are no toxicity reference values (TRVs) associated with an expected level of effect. The HQ is calculated as the quotient of the exposure concentration or dose and the TRV. Terrestrial receptors evaluated included plants, soil-dwelling invertebrates (earthworms), mammalian herbivores (deer mice and white-tailed deer), insectivorous mammals (shrews), and top predators (red foxes and red-tailed hawks). Sediment and surface water receptors evaluated included sediment biota, aquatic biota, herbivores (mallard ducks and muskrats), and top predators (mink and great blue heron).

6.1 SUMMARY OF ECOLOGICAL RISK ASSESSMENT

The BERA (Level III Baseline) identified multiple COECs in surface soils, subsurface soils, sediments, and groundwater in the EBG Phase II RI (USACE 2005c). A total of 45 chemicals were retained as COPECs for surface soil, 18 chemicals were retained as COPECs for subsurface soil (1 to 3 ft BGS), 40 chemicals were retained as COPECs for sediment, and 17 chemicals were retained as COPECs for surface water. Because COPECs were identified and retained for surface and subsurface soil, sediment, and surface water, ecological conceptual site models (CSMs) were prepared, along with the identification of site-specific ecological receptors, relevant and complete exposure pathways, and candidate assessment endpoints. These types of information were used to prepare a Level III Baseline.

Forty-three COECs for surface soil were identified for the exposure unit (EU) at EBG; three of the surface soil COPECs from the Level II SERA were identified as qualifying for NFA during the Level III BERA. Fifteen COECs for subsurface soil were identified for the EU at EBG. Four subsurface soil COPECs from the Level II SERA were identified as qualifying for NFA during the Level III BERA. Fifty-eight COECs for sediment were identified at the EU at EBG; however, only one surface soil COPEC from the Level II SERA qualified for NFA during the Level III BERA. Nineteen COECs were identified for surface water at the surface water EU. None of the surface water COPECs from the Level II SERA qualified for NFA during the Level III BERA. Table 6-1 presents an overview of highest HQ values in soils. Further information about the COECs in the EBG media is found in Table 7-8 of the EBG Phase II RI (USACE 2005c).

Table 6-1. Overview of Highest Media HQs for COECs at EBG – BERA (Level III)

Media	COEC	HQ (receptor)
Surface Soil	Iron	2,500 (plant)
	Aluminum	842 (shrew)
	Chromium	57 (worm)
Subsurface Soil	Antimony	3.2 (shrew)
	Zinc	2.4 (plant)

6.2 ECOLOGICAL PROTECTION

The ERA performed for EBG is available in the Phase II RI Report. Ohio EPA Levels I, II, and III were performed for EBG and show observed concentrations and TRVs where HQs exceed one. The ERA in the EBG Phase II RI Report identifies a variety of ecological receptor populations that could be at risk and identify the COPECs and COECs that could contribute to potential risks from exposure to contaminated media.

The ERA contains findings of (1) a qualitative ecological reconnaissance of EBG's vegetation and wildlife, and (2) a quantitative application of the Ohio Rapid Assessment Method for wetlands. These findings were published in the EBG Phase II RI Report. A facility-wide biology and surface water study provides further information for consideration at EBG. This information has been published in the facility-wide biological and water quality study (USACE 2005a) and is summarized in the EBG Phase II RI Report. All the studies document the presence of healthy and functioning terrestrial and aquatic ecosystems.

These two pieces of information [risk assessment predictions (e.g., HQs) and field observations] were combined in weight-of-evidence assessments. This combination of information shows that (1) while ESV exceedance and HQs > 1 suggest risk to plants and selected animals at EBG, (2) the field observations reveal the ecological system with the plants and animals is functioning well and organisms appear to be healthy. Further, where surface water is involved, the use of attainments are being met per Ohio guidance. Findings indicate no ecological preliminary cleanup goals are recommended and no remediation for ecological risks is justified at EBG. The rationale for this is explained and summarized in sections below.

6.2.1 Ecological Preliminary Cleanup Goals for EBG

Ohio EPA guidance (Ohio EPA 2003) allows decisions regarding the need for remediation to be made at the completion of each level of the ERA process. The remedial alternatives evaluation process includes the development of preliminary cleanup goals or COEC concentrations used to define areas where remediation is needed to achieve protectiveness for ecological resources. A decision whether it is necessary to remediate because of potential harm to ecological receptors and whether it is necessary to set preliminary cleanup goals for ecological receptors at EBG is not included in the EBG Phase II RI Report. However, the following weight-of-evidence discussions provide input for that decision.

It is recommended that no quantitative preliminary cleanup goals to protect ecological receptors be developed at EBG. This recommendation comes from applying steps in the Facility-Wide Ecological Risk Work Plan and specifically steps in Figure III to reach a Scientific Management Decision Point (SMDP) that few ecological resources are at risk. This recommendation is based primarily on the following three weight-of-evidence conclusions:

- Field observations (Level I of Ohio EPA protocol, Ohio Rapid Assessment Method for Wetlands with its high score of 81, and Facility-Wide Biological and Surface Water Study) indicate that surface water and wetland portions of EBG represent a unique resource in the form of a Category 3 wetland (highest evaluation). Also, field reconnaissance (USACE 2005c) indicates that the terrestrial portion of EBG represents an ecological resource typical of many nearby and other RVAAP habitats.

- Soil HQs are generally not highly elevated and impacts to aquatic and terrestrial ecological resources are not observed or expected. Regardless, some ecological risk from chemicals has been predicted in both the wetladns and terrestrial portions of EBG.

- Removal of soil or sediment to further reduce any adverse ecological effects from chemicals could destroy unique wetland resources and terrestrial habitat without substantial benefit to those same ecological resources at EBG.

Stewardship of the environment will be a major consideration in all phases of planning, design, and implementation of the military mission at EBG. Presently, ecological risk is possible. However, the HQs are mostly less than 1 and, with the exception of iron and aluminum, the HQs are less than 60. Biological measurements showing a quality wetland and functioning aquatic ecosystem near EBG corroborate the generally low HQs (i.e., low ecological risk). Any chemical remediation for ecological protection must be balanced by the negative consequences to the physical habitat. Remediation at EBG is likely to destroy valuable habitat, especially high quality wetland. Considering the rather low concentrations of many COECs and the lack of readily observed harm to the environment, remediation or habitat destruction is not justified at EBG.

6.2.2 Ecological Cleanup Goal Development Weight of Evidence

This section provides a rationale for why remediation for protection of ecological receptors and the associated development of quantitative preliminary cleanup goals is not warranted for ecological risks at this time. The rationale includes:

- Onsite or near-site field studies show a healthy aquatic ecosystem (implying a healthy terrestrial ecosystem) [Level I of Ohio EPA protocol, Ohio Rapid Assessment Method for Wetlands, and Facility-Wide Biological and Water Quality Study (USACE 2005c)] and full attainment status according to Ohio EPA guidance despite the BERA indication of risks to ecological receptors based on HQs above 1.

- Soil HQs are generally not highly elevated.

- A high quality wetland (Category 3 wetland with a Ohio Rapid Assessment Method of Wetland score of 81) is found at EBG. Terrestrial portions of EBG represent typical terrestrial habitat and other nearby terrestrial habitat offers home ranges for terrestrial wildlife.

- Significant contaminant migration is not expected to occur from soils to nearby aquatic environments.

- Mitigations are of two types (chemical and physical) where removal of impacted soils/sediments (i.e., chemical) would lower the exposure and ecological risk and physical alteration (such as vegetation removal) is a trade-off.

6.2.2.1 Ecological Reconnaissance, Ohio EPA/USACE Biology and Surface Water Study, and Wetland Assessment Show Functioning Ecological System

Level IV of the ERA process (Ohio EPA 2003) is an evaluation of exposures and any observable adverse ecological effects at an AOC. Observation of a healthy ecological community can mitigate the conclusions resulting from risk calculations based on theoretical exposure models. Although a Level IV risk assessment was not performed, field observations were made. These observations indicate that despite the presence of COPECs, little adverse ecological effect has occurred at EBG.

Ecological reconnaissance at EBG concluded that vegetation and animals are found at EBG (USACE 2005c). In general, vegetation consists of old-field communities with corridors and relatively large patches of forest vegetation. Animals consist of soil invertebrates, many species of insects, mammals, (including nearby beavers) and birds. Further, a unique wetland resource and a few protected state-listed species and unqiue natural resources are found at EBG. For example, according to the INRMP (2001), "The swamp forest along Blackberry Lane (the road that forms the northern boundary of EBG) is one of the best examples of a swamp forest community in northern Ohio. The EBG beaver impoundments (downstream of EBG) and associated wetlands contain several plant species that are uncommon to RVAAP. The plant species include tussock sedge (*Carex stricta)*, bulbiferous water-hemlock *(Cicuta bulbifera)*, bristly crowfoot (*Ranunculus pensylvanicua)*, and swamp dock *(Rumex orbiculatus)*. EBG

contains no state-listed plant species, but is an important wetland for wildlife (see the paragraph on surface water and wetlands in this section). Therefore, National Guard land use (restricted access with dust/fire suppression and hunting) would be carried out in an environment in which the minor impact would be limited to "normal" ecological resources, and managed to avoid any harm to a high quality wetland at EBG.

Surface water represents a dominant part of EBG. A facility-wide surface water investigation has been completed by USACE with cooperation with Ohio EPA. A brief description of Ohio EPA/USACE Biology and Surface Water Study can be found in Section 7.3.1.5 of the EBG Phase II RI (USACE 2005c).

The surface water attracts many types of life, including waterfowl and fish. The adjacent wetlands constitute a high quality habitat, as shown by the Ohio Rapid Assessment Method. The EBG wetland is a Category 3 wetland (although an official jurisdictional delineation has not been completed) defined according to Ohio EPA (2001) as having "…superior habitat …typified by high levels of diversity, a high proportion of native species, and/or high functional values. Category 3 wetlands include wetlands which contain or provide habitat for threatened or endangered species…". For example, the Marsh wren (*Cistothorus palustris*) is a state-listed species of concern that has been identified at EBG. And several state-listed migrant birds have been identified at EBG: Northern shoveler (*Anas clypeata*), Green-winged teal (*Anas crecca*), and Ruddy duck (*Oxyura jamaicensis*) (Elgin, K, 2006). Details of the methods and results of the Ohio Rapid Assessment Method can be found in Section 7.3.1.3 of the EBG Phase II RI (USACE 2005c).

6.2.2.2 Low Levels of Soil Contamination

Terrestrial habitats at EBG do not have the same rigorous level of biological measurements as the aquatic environments; however, most of the soil HQs that exceed 1 are less than 10. Three metals (chromium, aluminum, and iron) have HQs greater than 10 for low trophic level receptors. The EPC for aluminum (13,300 mg/kg) is less than the background criterion (17,700 mg/kg) for this metal and the EPCs for chromium (23 mg/kg) and iron (24,900 mg/kg) are slightly above surface soil facility-wide background values (17.4 mg/kg and 23,100 mg/kg, respectively). Furthermore, the HQs for iron and aluminum are likely overestimated due to low availability of the constituents for biological uptake from soils (aluminum) or low confidence in the TRV (iron).

Chromium is an example of a metal that occurs in different chemical forms with different bioavailabilities and toxicities. Chromium exists in different oxidation states, predominantly as trivalent chromium [Cr (III)] and hexavalent chromium [Cr (VI)]; Cr (III) is less bioavailable and less toxic than Cr (VI). Natural Cr (VI) is rare in nature (James 2002), and was not detected in the soil samples. Nearly all naturally occurring chromium is in the form of the Cr^{+3} (chromic) cation, which is in the Cr (III) oxidation state. Compounds of Cr (III) such as chromic acetate [Cr $(CH_3O_2)_3$] or chromic sulfate [Cr_2 $(SO_4)_3$] are soluble in water because they disassociate into Cr^{+3} ions and the corresponding anions (e.g., acetate and sulfate), which are soluble. However, Cr^{+3} ions react with negatively charged ions in soils and sediments and can form insoluble precipitates, which are not bioavailable. For example, Cr^{+3} reacts readily with hydroxide ions (OH^-) to form $Cr(OH)_3$, which has a solubility of about 5×10^{-8} µg Cr/L at pH 8 (James 2002) and is,

therefore, not bioavailable. Some chromates, especially $BaCrO_4$, $HgCrO_4$, and $PbCrO_4$ are also very poorly soluble in water (Clifford 1988) and, therefore, are not readily bioavailable. Thus, Cr(III) forms insoluble compounds in soils that are not bioavailable.

6.2.2.3 Nearby Habitats Offer Home Ranges to Wildlife

As stated above, ecological resources at the surface water and wetland portions of EBG are high quality Category 3 wetlands. By contrast, the terrestrial portion of habitat is normal and is available to receive any wildlife that may leave EBG. Very little vegetation is expected to be removed from within EBG. Old-field vegetation could be mowed or cleared in another way to make access to the wetland. Wildlife could be disturbed by the movement and noise of equipment as well as operations. Wildlife can leave and enter adjacent old fields, forest patches, vegetative corridors, and other wetlands. RVAAP has thousands of acres of habitat like that at EBG in which to find new home ranges. Therefore, any lack of protection as a result of not developing and applying ecological preliminary cleanup goals would be minimal because sufficient reservoirs of habitat and wildlife exist to maintain facility-wide ecological communities.

6.2.2.4 No to Low Contaminant Migration

The facility-wide surface water sampling and assessment revealed that surface water quality in the streams at RVAAP was good to excellent with few exceedances of Ohio Water Quality Standards criteria. However, this does not preclude investigating surface water and sediments on an individual basis as required by Ohio EPA.

At EBG, offsite migration is possible because water can theoretically move offsite. However, the wetland lies in depressions with beaver dams adding to the retention of water. There could be onsite contaminant movement and, for this reason, a qualitative assessment was made.

Several lines of evidence and reasoning suggest that soil constituents are unlikely to result in higher exposure and higher HQs for aquatic receptors in the future at EBG. These lines of evidence and reasoning are as follows.

Conditions at EBG

The transport by erosion of soil constituents to surface water or sediments in the wetland at EBG is likely to be small. EBG has predominately short slope lengths and low slope, with the exception of the steep sides of the former railroad bed. The Sebring soils of the EBG, which is located in the northeastern portion of the RVAAP, have moderate erodibility (0.34), but high forest and understory cover reduce by several orders of magnitude the potential soils loss that could result from rainfall levels typical of temperate regions (42 in/year). Soil loss, with its adsorbed chemical load, is thus not expected to be a large future source of contaminants to the wetland.

Minimal Leaching to Wetland Surface Water and Sediment

Future transport by leaching of soil constituents to surface water or sediments in EBG wetland is also likely to be small for most organics and many inorganic constituents. The affinity of a constituent for soils is characterized by a partitioning coefficient. For organics, the coefficient used is the organic carbon-partitioning coefficient (K_{OC}), which is defined as the ratio of the concentration of the constituent associated with soil organic carbon (mg/kg carbon) to the equilibrium concentration in water (mg/L). For inorganics, the coefficient used is the soil-water equilibrium-partitioning coefficient (K_d), which is defined as the ratio of the concentration of the constituent in soils (mg/kg soils) to the equilibrium concentration in water (mg/L). These coefficients were used to make predictions about the potential future concentrations of soil COPECs in surface water and sediments at EBG.

The potential for an organic constituent in soils to move into surface water is indicated by its K_{OC}. For example, nitrocellulose and acetone are found in both subsurface soils (1-3 ft BGS) and surface water at EBG wetland (Table 6-2). Nitrocellulose has a K_{OC} of 10, and acetone has a K_{OC} of 0.95. In contrast, the semivolatile organics are found in soils but not in surface water (Table 6-2). These compounds have K_{OC} values that range from 23,000-1,800,000. This suggests that constituents with low affinity for soils are more likely to migrate to surface water than those with high affinity. The same principle applies to inorganics (i.e., inorganics with low K_ds are more likely to migrate to water than those with high K_d values).

Table 6-2 lists the SRCs and the COPECs identified in the Level II ERA for soils, sediments, and surface water at EBG. Only TNT and two volatiles (acetone and toluene) were found in all three media: soils, sediments, and surface water. Likewise, the few organic constituents and COPECs in surface water and sediments are generally not found in soils (Table 6-2). Organic compounds in soils and sediments would likely remain in place, and in general, organic compounds in soils and sediments are not found in surface water at the EBG. This is consistent with the generally high K_{OC} of organic compounds, 0.7% organic carbon content of soils, and the silty clay and clayey silt nature of the Sebring soils at the EBG (USACE 2005c).

All inorganic constituents (except for selenium, silver, and thallium) are found in all three media. One possible explanation for this distribution pattern is that inorganic constituents are more likely to have migrated directly and indirectly from soils to sediments and surface water and to remain there in a dissolved or particulate-bound state. Also, metals are naturally occurring components of soils and sediments.

Table 6-2. Distribution of COPECs in Environmental Media at EBG

Constituent	Surface Soil	Subsurface Soil	Sediments	Surface Water	Partitioning Coefficient (K_d)
Inorganics					
Aluminum	X[a]	--	X[a]	X[a]	1.50E+03 [b]
Antimony	X[a]	X[a]	X[a]	X	4.50E+01 [c]
Arsenic	X[a]	--	X[a]	X	2.90E+01 [c]
Barium	X[a]	X[a]	X[a]	X	4.10E+01 [c]
Beryllium	X	X	X[a]	--	7.90E+02 [c]
Cadmium	X[a]	X[a]	X[a]	X	7.50E+01 [c]
Calcium	X[a]	--	X[a]	X[a]	4.00E+00 [b]
Chromium	X[a]	--	X[a]	X	1.90E+01 [c]
Cobalt	X[a]	--	X[a]	X	4.50E+01 [b]
Copper	X[a]	X[a]	X[a]	X	3.50E+01 [b]
Cyanide	X[a]	--	X[a]	X	NA
Iron	X[a]	--	X[a]	X	2.50E+01 [b]
Lead	X[a]	X[a]	X[a]	X[a]	9.00E+02 [c]
Magnesium	X[a]	--	X[a]	X[a]	4.50E+00 [b]
Manganese	X[a]	--	X[a]	X	6.50E+01 [b]
Mercury	X[a]	X[a]	X[a]	X[a]	1.00E+03 [c]
Nickel	X[a]	--	X[a]	X	6.50E+01 [c]
Potassium	X[a]	--	--	X[a]	5.50E+00 [b]
Silver	X[a]	--	X[a]	--	8.30E+00 [c]
Sodium	X[a]	X[a]	X[a]	X	1.00E+02 [b]
Thallium	X[a]	--	--	--	7.10E+01 [c]
Vanadium	X[a]	--	X[a]	X	1.00E+03 [b]
Zinc	X[a]	X[a]	X[a]	X	6.21E+01 [c]
Organics-Explosives					
1,3-Dintrobenzene	--	--	--	X	2.06E+01 [c]
2,4,6-Trinitrotoluene	X	X	X[a]	X	1.83E+03 [d]
2,6-Dinitrotoluene	--	--	X[a]	--	4.19E+01 [c]
2-Amino-4,6-dinitro	X[a]	--	--	--	4.19E+01 [e]
3-Nitrotoluene	--	--	--	X	4.27E+02 [f]
4-Amino-2,6-	X[a]	--	--	--	4.19E+01 [e]
4-Nitrotoluene	X[a]	--	--	--	4.27E+02 [f]
HMX	--	--	--	X	1.85E+03 [d]
Nitrobenzene	--	--	X[a]	--	1.19E+02 [c]
Nitrocellulose	X[a]	X[a]	X[a]	X[a]	1.00E+01 [d]

Table 6-2. Distribution of COPECs in Environmental Media at EBG (continued)

Constituent	Surface Soil	Subsurface Soil	Sediments	Surface Water	Partitioning Coefficient (K_d)
Organics-Semivolatiles					
2-Methylnapthalene	X	--	--	--	4.47E+03 [g]
4-Methylphenol	--	--	--	X	4.34E+00 [d]
Acenaphthylene	X[a]	--	--	--	6.76E+03 [g]
Anthracene	X[a]	--	--	--	2.35E+04 [c]
Aroclor-1254	--	--	X[a]	--	4.48E+04 [d]
Benzo(a)anthracene	X[a]	X[a]	X[a]	--	2.60E+05 [c]
Benzo(a)pyrene	X[a]	X[a]	X[a]	--	9.69E+05 [c]
Benzo(b)fluoranthene	X[a]	X[a]	X[a]	--	8.36E+05 [c]
Benzo(g,h,i)perylene	X[a]	--	X[a]	--	1.82E+06 [g]
Benzo(k)fluoranthene	X[a]	X[a]	X[a]	--	8.32E+05 [h]
Bis(2-ethylhexyl)phthalate	X[a]	X[a]	X[a]		1.11E+05 [h]
Butylbenzylphthalate	--	--	X[a]	--	9.36E+03 [d]
Carbazole	X[a]	--	X[a]	--	1.13E+04 [d]
Chrysene	X[a]	X[a]	X[a]	--	2.97E+05 [c]
Dibenzo(a,h)anthracene	X[a]	--	--	--	1.79E+06 [c]
Di-n-butylphthalate	--	--	X[a]	--	1.46E+03 [d]
Fluoranthene	X[a]	X[a]	X[a]	--	4.91E+04 [c]
Fluorene	--	--	X[a]	--	7.71E+03 [c]
Indeno(1,2,3-cd) pyrene	X[a]	X[a]	X[a]	--	4.11E+06 [c]
Methoxychlor	--	--	X[a]	--	8.00E+04 [c]
Naphthalene	X[a]	--	--	--	1.19E+03 [c]
N-nitrosodiphenylamine	--	--	X[a]	--	5.62E+03 [d]
Phenanthrene	X[a]	X[a]	X[a]	--	2.09E+04 [h]
Phenol	--	--	--	X	2.20E+01 [c]
Pyrene	X[a]	X[a]	X[a]	--	6.80E+04 [c]
Organics-Volatiles					
2-Butanone	--	--	X[a]	--	2.34E+00 [c]
Acetone	X	X	X[a]	X[a]	9.51E-01 [c]
Carbon disulfide	--	--	--	X	5.14E+01 [c]
Chloroform	--	--	--	X	5.30E+01 [c]
Chloromethane	--	--	--	X[a]	6.00E+01 [c]
Methylene chloride	X	X	--	--	1.00E+01 [c]
Toluene	X	X	X	X	1.40E+02 [c]

COPEC = Constituent of potential ecological concern retained based on Data and Media Evaluation as reported in Erie Burning Grounds (EBG) Remedial Investigation (RI) Report Tables O-5 through O-8 (USACE 2005c).

"X" indicates COPEC.

[a] Level II COPEC retained based on potential toxicity and bioaccumulation hazard as reported in EBG RI Report Tables O-9 through O-12 (USACE 2005c).

[b] Baes et al. (1984).

[c] Section 5 and/or Appendix A-3 of the Human Health Risk Assessment Protocol (U. S. Environmental Protection Agency [USEPA] 1998).

[d] Calculated using USEPA EpiSuite; see http://www.epa.gov/oppt/exposure/docs/episuitedl.htm.

[e] Value for 2,6-Dinitrotoluene from Baes et al. (1984).

[f] Value for 2-Nitrotoluene from Mackay et al. (1992).

[g] Mackay et al. (1992).

[h] Errata to Human Health Risk Assessment Protocol (USEPA 1999a).

Current Conditions are Not Adverse and Not Expected to Change

The strongest argument for concluding that current constituent concentrations in soils do not pose an increased future risk to ecological receptors exposed to surface water and sediments in EBG wetland is that the current conditions are not adverse and in the adjacent wetland are functioning well and nothing is expected to change. For example, the wetland assessment rated the EBG wetland as high quality. Also, the results of the macroinvertebrate survey at the EBG from the site-wide biological and surface water study indicate that the EBG wetland is a high quality habitat. This is expected given that sufficient rain has fallen and time has lapsed since operations ceased at EBG. Labile soil constituents may have already leached to deep soil horizons or in the sediments or the constituents may have migrated to the wetland and the ultimate offsite sink. More recalcitrant constituents are likely to continue to remain in the soils or be to released slowly, as to be in equilibrium with losses from the system. Likewise, water levels have undoubtedly fluctuated seasonally and annually with fluctuations in rainfall and the constructive and destructive activities of beavers and humans, respectively, for low lying areas to be wetted and dried enough times to have mobilized most soil constituents that can be mobilized.

The qualitative evaluation of the interaction between land and water at EBG is comprehensive and provides a feasible explanation of why soil impacts to water are not going to increase in the future at EBG and, therefore, that the low HQs (Level III computations) and low ecological effects (site-wide biological and water study and the wetland study) are not expected to change in the future. Current rates of erosion and leaching are likely small and unlikely to change in the future. Rainfall amounts and water levels in the wetland will likely fluctuate in the future similarly to how they have fluctuated over the past decades since contaminants were released to soils. Therefore, it is likely there will be no increase in the flux of both organics and inorganic COPECs from soils to the wetland in the future and no increase in HQs for aquatic receptors.

6.2.2.5 Mitigation Trade-Off of Reducing Ecological Risk but Harming Environment

There is a trade-off of two kinds of ecological risk: physical alterations and residual contamination. That is, the localized ecosystem either can have clean soils/sediments because of removal and replacement but have a highly disturbed habitat as a result, or it can have exposure to contaminants in a habitat that is minimally disturbed. In some cases, it can be appropriate to allow plants and animals low in the food chain to be exposed to somewhat toxic concentrations, sparing important habitat, if animals higher in the food chain (especially top carnivores) are not receiving toxic exposures. In the case of EBG activities, the military mission does not require activities that will alter habitat or create high noise levels, thereby, not resulting in much change to the presence and the exposure of ecological receptors.

There may be little benefit to removing contaminated media because COPEC concentrations are not necessarily at harmful levels according to the field investigations. For example, of the eleven metal COPECs in soils (Table 6-2), four COECs, including iron and aluminum, have concentrations below 3 times background criteria. This small factor means that concentrations are not likely to be an exposure and risk issue.

In conclusion, any remediation for ecological protection purposes can cause more habitat damage than chemical risk reduction is worth.

6.3 SUMMARY

There is mathematically predicted ecological risk at EBG; however, field observations (Level I of Ohio EPA protocol, Ohio Rapid Assessment Method for wetlands, and Facility-Wide Biological and Surface Water Study) show healthy and functioning terrestrial, aquatic, and wetland ecosystems. The wetland constitutes a Category 3 wetland of high quality and any remediation could harm that precious ecological resource. After applying this information along with steps in the Facility-Wide Ecological Risk Work Plan, a SMDP is reached that quantitative preliminary cleanup goals to protect ecological resources do not need to be developed at EBG.

7.0 CONCLUSIONS AND RECOMMENDATIONS

This RI Addendum documents the updated fate and transport analysis, HHRA, and ERA at EBG. Chemical-specific preliminary cleanup goals were established for Fire/Dust Suppression Worker, Resident Subsistence Farmer, and for the National Guard Trainee. Preliminary cleanup goals for Fire/Dust Suppression Worker land use were established for likely future land use by OHARNG. Preliminary cleanup goals were also established for National Guard Trainee land use in the event of changes to plans for future land use.

EBG will be transferred to NGB and subsequently licensed to the OHARNG for use as a military training site. EBG is not currently a candidate for residential release due to the potential for MEC and the presence of environmentally sensitive areas (i.e., wetlands). Preliminary cleanup goals however were established for a Resident Subsistence Farmer (adult and child) to provide a baseline for evaluating whether EBG may be eligible for residential release.

Therefore, it is recommended that EBG undergoes NFA with respect to chemical contamination in soils/dry sediments. MEC issues at EBG will be addressed under the MMRP. Interim use restrictions will be maintained at EBG until such time that a final remedial decision regarding MEC is determined under the MMRP. No human health COCs are identified for evaluation of remedial alternatives in soils/dry sediments for the Fire/Dust Suppression Worker land use or Resident Subsistence Farmer land use at EBG. One COC (chromium) was identified for National Guard Trainee land use; however, National Guard Trainee land use is not a reasonable, foreseeable land use due to physical constraint (e.g., wetlands, MEC). If military land use of EBG changes in the future, then exposure to chromium may need to be re-evaluated. The terrestrial and aquatic ecosystems, including a Category 3 wetland, are relatively healthy and functioning and no preliminary cleanup values for ecological resources are recommended.

One human health COC (antimony) was identified in wet sediments for Residential Subsistence Farmer land use. Recommendations regarding wet sediments, surface water, and groundwater are not within the scope of this RI Addendum and any necessary action with respect to these media will be established in future decisions.

Since NFA is recommended with respect to soils/dry sediments, further evaluation in an FS is not necessary. The next step in the CERCLA process is to prepare a Proposed Plan. The Proposed Plan will solicit public input with respect to NFA for soils and dry sediments at EBG.

The Record of Decision (ROD) will document the remedy for soils and dry sediments at EBG. Comments on the Proposed Plan received from state and federal agencies and the public will be considered in drafting the ROD for EBG. The ROD will provide a brief summary of the history, characteristics, risks, and selected remedy. The ROD also will include a responsiveness summary, addressing comments received on the Proposed Plan.

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Appendix A
Risk Characterization for Trespasser Scenario

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

ALM	adult lead model
AOC	area of concern
BGS	below ground surface
COC	constituent of concern
COPC	constituent of potential concern
cPAH	carcinogenic polycyclic aromatic hydrocarbon
CSF	cancer slope factor
DNT	dinitrotoluene
EBG	Erie Burning Grounds
EPC	exposure point concentration
FWHHRAM	Facility Wide Human Health Risk Assessor Manual
GAF	gastrointestinal absorption factor
HHRA	Human Health Risk Assessment
HI	hazard index
ILCR	incremental lifetime cancer risk
IEUBK	Integrated Exposure Uptake Biokinetic
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
RfC	reference concentration
RfD	reference dose
RI	Remedial Investigation
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
TEF	toxicity equivalent factor
USACE	U. S. Army Corps of Engineers
USEPA	U. S. Environmental Protection Agency
VOC	volatile organic compound

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A.0 RISK CHARACTERIZATION FOR TRESPASSER SCENARIO

A.1 INTRODUCTION

The baseline Human Health Risk Assessment (HHRA) provided in the Remedial Investigation (RI) Report for Erie Burning Grounds (EBG) evaluates the potential health risks to humans resulting from exposure to contamination at EBG. The HHRA presented in the RI Report is based on the methods outlined in the Ravenna Army Ammunition Plant (RVAAP) Facility-Wide Human Health Risk Assessor Manual (FWHHRAM) [U. S. Army Corps of Engineers (USACE) 2004], which addresses five receptors to be evaluated at RVAAP [National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer (adult and child)].

An additional receptor (trespasser scenario) was added in an addendum to the FWHHRAM (USACE 2005b) released in November 2005. The Trespasser (Juvenile and Adult) is evaluated in this RI Addendum to supplement the baseline HHRA provided in the RI Report to comply with the revised FWHHRAM and to provide risk managers with information to support determination of the need for continued security at the facility. This supplemental risk characterization is organized into the same six major sections used in the baseline HHRA:

- Data evaluation and constituents of potential concern (COPCs) are discussed in Section A.2;
- Exposure assessment is presented in Section A.3;
- Toxicity assessment is summarized in Section A.4;
- Results of the risk characterization are presented in Section A.5;
- The uncertainty analysis is presented in Section A.6; and
- The conclusions of the HHRA are summarized in Section A.7.

A.2 DATA EVALUATION

Data evaluation and COPC screening were conducted as part of the baseline HHRA for EBG in the Phase II RI Report (USACE 2005c).

Under this scenario, the Trespasser (Juvenile and Adult) may be exposed to COPCs in shallow surface soil [0-1 ft below ground surface (BGS)], sediment, and surface water. This receptor is not exposed to COPCs in subsurface soil or groundwater. A summary of the exposure media evaluated for the Trespasser (Juvenile and Adult) scenario at each area of concern (AOC) is provided in Table A-1; a summary of the COPCs identified for each medium in the baseline HHRA is provided in Table A-2.

Table A-1. Exposure Media Evaluated for the Trespasser (Juvenile and Adult) Scenario

AOC	Exposure Media		
	Shallow Surface Soil[a]	Sediment	Surface Water
EBG	1 EU	1 EU	1 EU

[a]Shallow surface soil defined as 0-1 ft below ground surface (BGS) for the Trespasser scenario.
AOC = Area of concern.
EU = Exposure unit.
No COPCs = No constituents of potential concern (COPCs) identified for this exposure medium in the Remedial Investigation (RI) Report.

Table A-2. COPCs for Each Exposure Medium

COPC	Shallow (0-1 ft BGS) Surface Soil	Sediment	Surface Water
Quantitative COPCs[a]			
Inorganics			
Aluminum	X	X	X
Antimony	X	X	X
Arsenic	X	X	X
Barium	X	X	
Cadmium	X	X	X
Chromium[b]	X	X	X
Copper	X	X	
Lead[c]	X		
Manganese	X	X	X
Nickel		X	
Vanadium	X	X	X
Zinc	X	X	
Organics			
2,4,6-Trinitrotoluene	X	X	
Benz(a)anthracene	X		
Benzo(a)pyrene	X		
Benzo(b)fluoranthene	X	X	
Chloroform			X
Indeno(1,2,3-cd)pyrene	X		
Qualitative COPCs[d]			
Organics			
2-Amino-4,6-dinitrotoluene	X		
4-Amino-2,6-dinitrotoluene	X		
Benzo(g,h,i)perylene	X		
Nitrocellulose	X	X	X
Phenanthrene	X	X	

[a]Quantitative COPCs have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
[b]Chromium is conservatively evaluated with the toxicity values for hexavalent chromium.
[c]Although lead does not have toxicity values for which to quantify risks and/or hazards, it can be evaluated quantitatively with blood lead models from the U. S. Environmental Protection Agency.
[d]Qualitative COPCs do not have approved toxicity values that allow for further quantitative evaluation in the human health risk assessment.
BGS = below ground surface
COPC = Constituent of potential concern.
X = Constituent is a COPC for this medium.

A.3 EXPOSURE ASSESSMENT

One receptor (Trespasser [Juvenile and Adult]) is evaluated in this supplemental HHRA. RVAAP is a controlled access facility (i.e., it is fenced, gated, and patrolled by security guards); however, a trespasser could enter the property and be exposed to contaminants in shallow surface soil (0-1 ft BGS), sediment, and surface water at this AOC. The Juvenile Trespasser is assumed to visit the site approximately once per week (i.e., 50 days/year) between the ages of 8 and 18. The Adult Trespasser is assumed to visit the site slightly more often (75 days/year) for as long as he/she lives in the area (i.e., 30 years). In reality, the most likely adult trespassers are hunters or National Guard trainees entering unauthorized areas with a much lower frequency than the Hunter/Fisher/Trapper and National Guard Trainee receptors that are included in the baseline HHRA. A Juvenile Trespasser (ages 8 to 18) and Adult Trespasser are evaluated quantitatively for exposure to contaminated shallow surface soil (0-1 ft BGS) and sediment via incidental ingestion, inhalation of volatile organic compounds (VOCs) and particulates, and dermal contact. The Trespasser (Juvenile and Adult) is also evaluated for exposure to contaminated surface water via incidental ingestion and dermal contact.

Exposure equations for each of these pathways are provided in the FWHHRAM (USACE 2004). Exposure parameters used to calculate potential chemical intakes by the Trespasser (Juvenile and Adult) are from Table 5 of the FWHHRAM Amendment 1 (USACE 2005b) and are provided in Table A-3. Chemical-specific exposure parameters are provided for all COPCs in Table A-4 at the end of this appendix.

Table A-3. Exposure Parameters for Trespasser (Juvenile and Adult) Scenario[a]

Exposure Pathway and Parameter	Units	Value
Surface Soil[b]		
Incidental Ingestion		
Soil ingestion rate (Adult/Juvenile)	kg/day	0.0001 / 0.0002
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Fraction ingested	unitless	1
Conversion factor	days/hour	0.042
Dermal Contact		
Skin area (Adult/Juvenile)	m^2/event	0.57 / 0.815
Adherence factor (Adult/Juvenile)	mg/cm^2	0.4 / 0.2
Absorption fraction	unitless	Chemical Specific – Table A-4
Exposure frequency (Adult/Juvenile)	events/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45

Table A-3. Exposure Parameters for Trespasser (Juvenile and Adult) Scenario[a] (continued)

Exposure Pathway and Parameter	Units	Value
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	0.01
Inhalation of VOCs and Dust		
Inhalation rate	m^3/day	20
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Volatilization factor	m^3/kg	Chemical Specific – Table A-4
Particulate emission factor	m^3/kg	9.24E+08
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	days/hour	0.042
Sediment		
Incidental Ingestion		
Soil ingestion rate (Adult/Juvenile)	kg/day	0.0001 / 0.0002
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Fraction ingested	unitless	1
Conversion factor	days/hour	0.042
Dermal Contact		
Skin area (Adult/Juvenile)	m^2/event	0.57 / 0.815
Adherence factor (Adult/Juvenile)	mg/cm^2	0.4 / 0.2
Absorption fraction	unitless	Chemical Specific – Table A-4
Exposure frequency (Adult/Juvenile)	events/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	$(kg\text{-}cm^2)/(mg\text{-}m^2)$	0.01
Inhalation of VOCs and Dust		
Inhalation rate	m^3/day	20
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10

Table A-3. Exposure Parameters for Trespasser (Juvenile and Adult) Scenario[a] (continued)

Exposure Pathway and Parameter	Units	Value
Body weight (Adult/Juvenile)	kg	70 / 45
Volatilization factor	m^3/kg	Chemical Specific – Table A-4
Particulate emission factor	m^3/kg	9.24E+08
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	days/hour	0.042
Surface Water		
Incidental Ingestion		
Incidental water ingestion rate	L/day	0.1
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Dermal Contact		
Skin area (Adult/Juvenile)	m^2	0.57 / 0.815
Exposure time	hours/day	2
Exposure frequency (Adult/Juvenile)	days/year	75 / 50
Exposure duration (Adult/Juvenile)	years	30 / 10
Body weight (Adult/Juvenile)	kg	70 / 45
Carcinogen averaging time	days	25,550
Non-carcinogen averaging time (Adult/Juvenile)	days	10,950 / 3,650
Conversion factor	$(m/cm)(L/m^3)$	10

[a]Exposure parameters are from Table 5 of the Facility-Wide Human Health Risk Assessor Manual (FWHHRAM) Amendment 1 (USACE 2005b).
[b]Surface soil is defined as 0-1 ft below ground surface (shallow surface soil).
VOC = Volatile organic compound.

Exposure point concentrations (EPCs) were calculated for each exposure medium in the baseline HHRA, as detailed in the RI Report. These EPCs are provided in Tables A-9 through A-20 at the end of this appendix.

A.4 TOXICITY ASSESSMENT

Toxicity factors from U. S. Environmental Protection Agency (USEPA) sources are provided in Table A-5 [non-cancer reference doses (RfDs)] and Table A-6 cancer slope factors (CSFs) at the end of this appendix. These are the same toxicity factor values used to evaluate the five receptors evaluated in the baseline HHRA for EBG.

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) (USEPA 1989). The Juvenile Trespasser scenario assumes an exposure duration of 10 years and the

Adult Trespasser assumes an exposure duration of 30 years; therefore, only chronic RfDs are used in this supplemental HHRA.

Reference air concentrations (RfCs) and inhalation unit risks were converted to RfDs and CSFs using default adult inhalation rate and body weight [i.e., (RfC × 20 m3/day)/70 kg = RfD, Unit Risk × 70 kg × 1,000 μg/mg)/20 m3/day = CSF] (USEPA 1989).

Dermal RfDs and CSFs are estimated from oral toxicity values using chemical-specific gastrointestinal absorption factors (GAFs) to calculate total absorbed dose, as recommended by USEPA (2004). The GAF values used and resulting dermal toxicity values are listed in Tables A-5 and A-6 at the end of this appendix.

As discussed in the baseline HHRA, total chromium is evaluated using the toxicity values for hexavalent chromium at EBG. This is the form of chromium with the most conservative toxicity values.

Per the FWHHRAM (USACE 2004), toxicity equivalence factors (TEFs) are applied to carcinogenic polycyclic aromatic hydrocarbons (cPAHs) to convert the cPAHs to an equivalent concentration of benzo(a)pyrene.

No RfDs or CSFs are available for some COPCs because the non-carcinogenic 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, their effects cannot be quantified at the present time. COPCs without RfDs and CSFs are 2-amino-4,6-dinitrotoluene (DNT); 4-amino-2,6-DNT; nitrocellulose; benzo(g,h,i)perylene; and phenanthrene.

No RfDs or CSFs are available for lead. USEPA (1999b) recommends the use of the interim adult lead model (ALM) 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. Complete documentation of the model is available at: http://www.epa.gov/superfund/programs/lead/products/adultpb.pdf (USEPA 2003). 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 A-7 (Juvenile Trespasser) and A-8 (Adult Trespasser) at the end of this appendix. The Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children (available at http://www.epa.gov/superfund/programs/lead/ieubk.htm) was not used to evaluate the Juvenile Trespasser because this receptor is assumed to be age 8 to 18 years and the IEUBK applies to children age 0 to 6 years.

A.5 RISK CHARACTERIZATION RESULTS FOR TRESPASSER FOR EBG

Risk characterization integrates the findings of the exposure and toxicity assessments to estimate the potential for receptors to experience adverse effects as a result of exposure to contaminated media. Risk

characterization for the Trespasser (Juvenile and Adult) in this supplemental HHRA follows the same methodology used for risk characterization for the other receptors evaluated in the baseline HHRA. Risk characterization results including identification of constituents of concern (COCs) are presented for in the following subsections. COCs are defined as COPCs having an incremental lifetime cancer risk (ILCR) greater than 1.0E-06 and/or an hazard index (HI) greater than 1.

A.5.1 EBG Surface (0-1 ft BGS) Soil

Detailed hazard and risk results for direct contact with COPCs in shallow surface soil (0-1 ft BGS) are presented in Tables A-9 and A-10 (Juvenile Trespasser) and A-11 and A-12 (Adult Trespasser) at the end of this appendix. Direct contact includes incidental ingestion of soil, inhalation of VOCs and particulates (i.e., dust) from soil, and dermal contact with soil.

The total HIs for the Juvenile Trespasser and Adult Trespasser exposed to shallow surface soil are 0.017 and 0.018, respectively, which are below the threshold of 1.0; thus, no non-carcinogenic shallow surface soil COCs are identified at EBG for either receptor.

The total risk across all COPCs for the Juvenile Trespasser exposed to shallow surface soil is 7.7E-07, which is below the threshold of 1.0E-06; thus, no carcinogenic shallow surface soil COCs are identified at EBG for this receptor. The total risk across all COPCs for the Adult Trespasser exposed to shallow surface soil is 2.8E-06, which is above the threshold of 1.0E-06. Arsenic is identified as a carcinogenic COC for the Adult Trespasser exposed to shallow surface soil at EBG; however, the arsenic risk (1.6E-06) is not in excess of Ohio Environmental Protection Agency's (Ohio EPA) level of concern of 1E-05 (Ohio EPA 2004b).

Lead was identified as a surface soil COPC at EBG. Lead model results for the Juvenile Trespasser and Adult Trespasser are provided in Tables A-7 and A-8, respectively, at the end of this appendix. The estimated probability of fetal blood lead concentrations exceeding acceptable levels is less than 1% for both the Juvenile Trespasser and Adult Trespasser exposed to shallow surface soil at EBG; therefore, lead is not a COC.

A.5.2 EBG Sediment

Detailed hazard and risk results for contact with COPCs in sediment are presented in Tables A-13 and A-14 (Juvenile Trespasser) and Tables A-15 and A-16 (Adult Trespasser) at the end of this appendix. Direct contact includes incidental ingestion of sediment, inhalation of VOCs and particulates (i.e., dust) from sediment, and dermal contact with sediment.

The total HIs for the Juvenile Trespasser and Adult Trespasser exposed to sediment are 0.055 and 0.051, respectively, which are below the threshold of 1.0; thus, no non-carcinogenic sediment COCs are identified at EBG for either receptor.

The total risk across all COPCs for the Juvenile Trespasser exposed to sediment is 6.5E-07, which is below the threshold of 1.0E-06; thus, no carcinogenic sediment COCs are identified at EBG for this receptor. The total risk across all COPCs for the Adult Trespasser exposed to sediment is 2.2E-06, which is above the threshold of 1.0E-06. Arsenic is identified as a carcinogenic COC for the Adult Trespasser exposed to sediment at EBG; however, the arsenic risk (2.0E-06) is not in excess of Ohio EPA's level of concern of 1E-05.

A.5.3 EBG Surface Water

Detailed hazard and risk results for direct contact with COPCs in surface water are presented in Tables A-17 and A-18 (Juvenile Trespasser) and Tables A-19 and A-20 (Adult Trespasser) at the end of this appendix. Direct contact includes incidental ingestion of surface water and dermal contact with surface water.

The total HIs for the Juvenile Trespasser and Adult Trespasser exposed to surface water are 0.59 and 0.45, respectively, which are below the threshold of 1.0; thus, no non-carcinogenic surface water COCs are identified at EBG for either receptor.

The total risks across all COPCs for the Juvenile Trespasser and Adult Trespasser exposed to sediment are 6.2E-06 and 1.7E-05, coming predominantly from arsenic. Arsenic is identified as a surface water COC at EBG for both receptors. The arsenic cancer risk for the Juvenile Trespasser is 5.6E-06, which is below Ohio EPA's level of concern of 1E-05. The arsenic cancer risk for the Adult Trespasser (1.7E-05, based on a concentration of 0.072 mg/L) is just above Ohio EPA's level of concern of 1E-05; an arsenic concentration of 0.043 mg/L would produce a risk of 1E-05.

A.5.4 Summary of Risk Characterization Results for Trespasser

Risks, hazards, and COCs are summarized in Table A-21 for the Trespasser (Juvenile and Adult) exposed to shallow surface soil (0-1 ft BGS), sediment, and surface water at EBG.

Table A-21. Summary of Risks and Hazards for Trespasser (Juvenile and Adult) at EBG

Exposure Medium	Total HI	Non-carcinogenic COCs	Total ILCR	Carcinogenic COCs
Juvenile Trespasser				
Shallow Surface Soil (0-1 ft BGS)	0.017	None	7.7E-07	None
Sediment	0.055	None	6.5E-07	None
Surface Water	0.59	None	6.2E-06	arsenic
Adult Trespasser				
Shallow Surface Soil(0-1 ft BGS)	0.018	None	2.8E-06	arsenic
Sediment	0.051	None	2.2E-06	arsenic
Surface Water	0.45	None	1.7E-05	arsenic

BGS = Below ground surface.
COC = Constituent of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.

A.6 UNCERTAINTY ANALYSIS

Uncertainties associated with each step of the risk assessment process (i.e., data evaluation, exposure assessment, toxicity assessment, and risk characterization) are described in the baseline HHRA.

While anticipated future land use has been identified for the RTLS (USACE 2004b), and the Ohio Army National Guard (OHARNG) will manage the property, there is uncertainty surrounding the future land use. To address some of this uncertainty a Trespasser (Juvenile and Adult) is evaluated in this supplemental risk assessment.

A.7 SUMMARY AND CONCLUSIONS

This supplemental HHRA was conducted to evaluate risks and hazards associated with impacted media at EBG for a Trespasser (Juvenile and Adult) scenario. The following steps were used to generate conclusions regarding human health risks and hazards:

- Identify COPCs (in the baseline HHRA included in the RI Report);
- Calculate risks and hazards; and
- Identify COCs.

At EBG, all HIs for the Trespasser (Juvenile and Adult) are below the threshold value of 1.0. The total ILCRs for the Juvenile Trespasser exposed to shallow surface soil (0-1 ft BGS) and sediment are below the threshold value of 1.0E-06, while the total ILCRs for the Adult Trespasser exposed to shallow surface soil and sediment are just above the threshold value of 1.0E-06. The total ILCRs for surface water exceed 1.0E-06 for both the Juvenile Trespasser and the Adult Trespasser. Arsenic is identified as the only COC for the Trespasser (Juvenile and Adult) at EBG.

Table A-4. Chemical-Specific Exposure Parameters

COPC	Dermal Absorption Factor[a] (unitless)	Permeability Constant[b] (cm/hr)	Volatilization Factor[c] (m^3/kg)
Inorganics			
Aluminum	1.0E-03	2.1E-03	--
Antimony	1.0E-03	1.1E-03	--
Arsenic	3.0E-02	1.9E-03	--
Barium	1.0E-03	4.0E-04	--
Cadmium	1.0E-03	3.5E-04	--
Chromium (as Chromium VI)	1.0E-03	1.0E-03	--
Copper	1.0E-03	3.1E-04	--
Manganese	1.0E-03	1.3E-03	--
Nickel	1.0E-03	3.3E-04	--
Vanadium	1.0E-03	1.4E-03	--
Zinc	1.0E-03	3.4E-04	--
Organics			
2,4,6-Trinitrotoluene	1.0E-01	1.1E-03	--
Benz(a)anthracene	1.3E-01	9.5E-01	--
Benzo(a)pyrene	1.3E-01	1.2E+00	--
Benzo(b)fluoranthene	1.3E-01	7.0E-01	--
Chloroform	1.0E-02	8.9E-03	2.8E+03
Indeno(1,2,3-cd)pyrene	1.3E-01	2.2E+00	--

[a] Chemical-specific absorption factor values from USEPA, 2004. When chemical-specific values are not available the following default values are used for soil and sediment only: SVOCs = 0.1, VOCs = 0.01, inorganics = 0.001 per USEPA Region 4 Supplemental Guidance to RAGS.
[b] From Risk Assessment Information System (RAIS) *http://risk.lsd.ornl.gov/tox/tox_values.shtml* for surface water.
[c] Volatilization factors (VFs) calculated using the 1996 USEPA Soil Screening Guidance Methodology, using site-specific parameter values for Cleveland, Ohio. Only used for soil and sediment VOCs.
COPC = Constituent of potential concern.
RAGS = Risk Assessment Guidance for Superfund.
SVOC = Semivolatile organic compound.
USEPA = United States Environmental Protection Agency.
VOC = Volatile organic compound.
-- = No value available.

Table A-5. Non-carcinogenic Reference Doses for COPCs

COPC	Oral Chronic RfD (mg/kg-day)	Confidence Level	% GI Absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
Inorganics								
Aluminum	1.0E+00	NA	1	1.0E+00	1.4E-03	NA	NA	(O) UF=10
Antimony	4.0E-04	Low	0.15	6.0E-05	--	Oral, oral-water	Gastrointestinal, liver, cardiovascular, and developmental toxicity	(O) UF=1000
Arsenic	3.0E-04	Medium (O)	0.95	3.0E-04	--	Oral, oral-water	Hyperpigmentation and keritosis and possible vascular complication	(O) UF=3
Barium	7.0E-02	Medium (O)	0.07	4.9E-03	1.4E-04	Oral, oral-water, inhalation	(O) increased blood pressure (human) (I) baritosis (human)	(O) UF=3 (I) UF=1000
Cadmium (soil/food)	1.0E-03	High	0.025	2.5E-05	--	Oral, oral-water	Renal toxicity, osteomalacia, osteoporosis, and significant proteinuria	(O) UF=1000
Cadmium (water)	5.0E-04	High	0.05	2.5E-05	--	Oral, oral-water	Renal toxicity, osteomalacia, osteoporosis, and significant proteinuria	(O) UF=1000
Chromium (as Cr VI)	3.0E-03	Low (O)	0.025	7.5E-05	2.9E-05	Oral (rat)	Reduced liver/spleen weight	(O) UF=100
Copper	4.0E-02	NA	1	4.0E-02	--	NA	NA	
Manganese (food)	1.4E-01	Medium (O)	0.04	5.6E-03	1.4E-05	Oral	(O) lethargy, tremors, mental disturbance, muscle tonus, and central nervous system effects	(O) UF=1 (O) MF=1
Manganese (soil/water)	4.6E-02	Medium (O)	0.04	1.8E-03	1.4E-05	Oral: water, inhalation	(O) lethargy, tremors, mental disturbance, muscle tonus, and central nervous system effects	(O) UF=1 (O) MF=1 (I) UF=1000
Nickel	2.0E-02	Medium	0.04	8.0E-04	--	Oral: diet (rat)	Decreased body & major organ weights (rat)	UF=100
Vanadium	7.0E-03	Low	0.026	1.8E-04	--	Oral (rat)	Decreased hair cystine	UF=100

Table A-5. Non-carcinogenic Reference Doses for COPCs (continued)

COPC	Oral Chronic RfD (mg/kg-day)	Confidence Level	% GI Absorption[a]	Dermal Chronic RfD (mg/kg-day)	Inhalation Chronic RfD (mg/kg-day)	RfD Basis (vehicle)	Critical Effect	Uncertainty/ Modifying Factor
Zinc	3.0E-01	Medium	0.3	9.0E-02	--	Oral	(O) copper deficiency & hypochromic microcytic anemia (human) (I) pulmonary & gastrointestinal effects (human)	UF=3
Organics								
2,4,6-Trinitrotoluene	5.0E-04	Medium	1	5.0E-04	--	Oral (dog)	Liver effects	UF=1000
Chloroform	1.0E-02	Medium (O)	1	1.0E-02	--	Oral	Liver fatty cyst formation (dog)	(O) UF=1000

[a] % GI absorption values from USEPA 2004.
(O) indicates oral, (I) indicates inhalation.
RfD = Reference dose.
MF = Modifying factor (the default modifying factor is 1).
UF = Uncertainty factor.
NA = Not available.
-- = No value available.
GI = Gastrointestinal.
USEPA = U. S. Environmental Protection Agency.

Table A-6. Cancer Slope Factors for COPCs

COPC	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	% GI Absorption[a]	Dermal Slope Factor $(mg/kg\text{-}day)^{-1}$	Inhalation Slope Factor $(mg/kg\text{-}day)^{-1}$	USEPA Class	TEF	Type of Cancer
Inorganics							
Arsenic	1.5E+00	0.95	1.5E+00	1.5E+01	A	--	Respiratory system tumors
Cadmium (soil/food)	--	0.025	--	6.3E+00	B1	--	Respiratory tract and lung tumors
Cadmium (water)	--	0.05	--	6.3E+00	B1	--	Respiratory tract and lung tumors
Chromium (as Cr VI)	--	0.025	--	4.2E+01	A	--	Lung tumors
Organics							
2,4,6-Trinitrotoluene	3.0E-02	1	3.0E-02	--	C	--	Bladder transitional cell papilloma
Benz(a)anthracene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Stomach tumors (mouse)
Benzo(a)pyrene	7.3E+00	0.58	7.3E+00	3.1E+00	B2	1	Stomach, nasal cavity, larynx, trachea, and pharynx
Benzo(b)fluoranthene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors
Chloroform	6.1E-03	1	6.1E-03	8.1E-02	B2	--	Colon, rectum, bladder, and liver carcinoma (mouse)
Indeno(1,2,3-cd)pyrene	7.3E-01	0.58	7.3E-01	3.1E-01	B2	0.1	Tumors

[a] % GI absorption values from USEPA 2004.
TEF = Toxicity Equivalency Factor is based on the relative potency of each carcinogenic polycyclic aromatic hydrocarbon (PAH) relative to that of benzo(a)pyrene.
-- = No value available.
GI = Gastrointestinal.
USEPA = U. S. Environmental Protection Agency.

Table A-7. EBG Shallow Surface Soil (0-1 ft BGS) Calculations of Blood Lead Concentrations for Juvenile Trespasser

Exposure Variable	PbB Equation[1]		Description of Exposure Variable	Units	Juvenile Trespasser	
	1*	2*			GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	ug/g or mg/kg	165	165
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	X	Baseline PbB	ug/dL	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.2	0.2
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	0.2	0.2
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	50	50
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			**ug/dL**	**2.4**	**1.9**
$PbB_{fetal, 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**5.7**	**5.8**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**
P(PbB > PbB_t)	**Probability that PbB > PbB_t, assuming lognormal distribution**			**%**	**0.5%**	**0.9%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When IRS = IR_{S+D} and WS = 1.0, the equations yield the same $PbB_{fetal,0.95}$.

* Equation 1, based on Eq. 1, 2 in U. S. Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.

$PbB_{adult} = (PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_{S,D}/AT_{S,D}) + PbB_0$.

$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$.

Table A-8. EBG Shallow Surface Soil (0-1 ft BGS) Calculations of Blood Lead Concentrations for Adult Trespasser

Exposure Variable	PbB Equation[1]		Description of Exposure Variable	Units	Adult Trespasser	
	1*	2*			GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	ug/g or mg/kg	165	165
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	1.8	2.1
PbB_0	X	X	Baseline PbB	ug/dL	2.2	1.7
IR_S	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.1	0.1
IR_{S+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	0.1	0.1
W_S		X	Weighting factor; fraction of IR_{S+D} ingested as outdoor soil	--	--	--
K_{SD}		X	Mass fraction of soil in dust	--	--	--
$AF_{S, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12
$EF_{S, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	75	75
$AT_{S, D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365
PbB_{adult}	**PbB of adult receptor, geometric mean**			**ug/dL**	**2.4**	**1.9**
$PbB_{fetal, 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**5.6**	**5.7**
PbB_t	**Target PbB level of concern (e.g., 10 ug/dL)**			**ug/dL**	**10.0**	**10.0**
P(PbB > PbB_t)	**Probability that PbB > PbB_t, assuming lognormal distribution**			**%**	**0.4%**	**0.8%**

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_S, K_{SD}). When IRS = IR_{S+D} and WS = 1.0, the equations yield the same $PbB_{fetal,0.95}$.

* Equation 1, based on Eq. 1, 2 in U. S. Environmental Protection Agency (USEPA) 2003. USEPA Technical Review Workgroup for Lead, Adult Lead Committee.

$PbB_{adult} = (PbS*BKSF*IR_{S+D}*AF_{S,D}*EF_{S,D}/AT_{S,D}) + PbB_0$.

$PbB_{fetal, 0.95} = PbB_{adult} * (GSD_i^{1.645} * R)$.

Table A-9. Juvenile Trespasser Shallow Surface Soil (0-1 ft BGS) Non-carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	6.7E-04	6.6E-05	7.3E-08	6.7E-04	6.6E-05	5.1E-05	7.9E-04	
Antimony	8.0E+00	4.0E-07	3.9E-08	4.4E-11	1.0E-03	6.6E-04		1.7E-03	
Arsenic	1.1E+01	5.5E-07	1.6E-06	5.9E-11	1.8E-03	5.4E-03		7.2E-03	
Barium	2.5E+02	1.3E-05	1.2E-06	1.4E-09	1.8E-04	2.5E-04	9.5E-06	4.4E-04	
Cadmium	1.8E+00	8.9E-08	8.7E-09	9.6E-12	8.9E-05	3.5E-04		4.4E-04	
Chromium	2.3E+01	1.2E-06	1.1E-07	1.2E-10	3.8E-04	1.5E-03	4.4E-06	1.9E-03	
Copper	8.2E+01	4.2E-06	4.1E-07	4.5E-10	1.0E-04	1.0E-05		1.1E-04	
Manganese	8.0E+02	4.1E-05	4.0E-06	4.4E-09	8.9E-04	2.2E-03	3.1E-04	3.4E-03	
Vanadium	2.1E+01	1.0E-06	1.0E-07	1.1E-10	1.5E-04	5.6E-04		7.1E-04	
Zinc	5.7E+02	2.9E-05	2.8E-06	3.1E-09	9.7E-05	3.1E-05		1.3E-04	
Inorganics Pathway Total					5.4E-03	1.1E-02	3.7E-04	1.7E-02	
2,4,6-Trinitrotoluene	4.8E-01	2.4E-08	2.4E-07	2.6E-12	4.9E-05	4.8E-04		5.3E-04	
Benz(a)anthracene	3.2E-01	1.6E-08	2.1E-07	1.8E-12					
Benzo(a)pyrene	3.2E-01	1.6E-08	2.1E-07	1.8E-12					
Benzo(b)fluoranthene	4.2E-01	2.1E-08	2.7E-07	2.3E-12					
Indeno(1,2,3-cd)pyrene	3.0E-01	1.5E-08	1.9E-07	1.7E-12					
Organics Pathway Total					4.9E-05	4.8E-04		5.3E-04	
Pathway Total - Chemicals					5.4E-03	1.1E-02	3.7E-04	1.7E-02	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.

Table A-10. Juvenile Trespasser Shallow Surface Soil (0-1 ft BGS) Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	9.6E-05	9.4E-06	1.0E-08					
Antimony	8.0E+00	5.8E-08	5.6E-09	6.2E-12					
Arsenic	1.1E+01	7.8E-08	2.3E-07	8.5E-12	1.2E-07	3.4E-07	1.3E-10	4.6E-07	
Barium	2.5E+02	1.8E-06	1.8E-07	1.9E-10					
Cadmium	1.8E+00	1.3E-08	1.2E-09	1.4E-12			8.7E-12	8.7E-12	
Chromium	2.3E+01	1.6E-07	1.6E-08	1.8E-11			7.5E-10	7.5E-10	
Copper	8.2E+01	6.0E-07	5.8E-08	6.5E-11					
Manganese	8.0E+02	5.8E-06	5.7E-07	6.3E-10					
Vanadium	2.1E+01	1.5E-07	1.5E-08	1.6E-11					
Zinc	5.7E+02	4.1E-06	4.0E-07	4.5E-10					
Inorganics Pathway Total					1.2E-07	3.4E-07	8.8E-10	4.6E-07	
2,4,6-Trinitrotoluene	4.8E-01	3.5E-09	3.4E-08	3.8E-13	1.0E-10	1.0E-09		1.1E-09	
Benz(a)anthracene	3.2E-01	2.3E-09	2.9E-08	2.5E-13	1.7E-09	2.1E-08	7.8E-14	2.3E-08	
Benzo(a)pyrene	3.2E-01	2.3E-09	3.0E-08	2.5E-13	1.7E-08	2.2E-07	7.8E-13	2.3E-07	
Benzo(b)fluoranthene	4.2E-01	3.0E-09	3.8E-08	3.3E-13	2.2E-09	2.8E-08	1.0E-13	3.0E-08	
Indeno(1,2,3-cd)pyrene	3.0E-01	2.2E-09	2.8E-08	2.4E-13	1.6E-09	2.0E-08	7.3E-14	2.2E-08	
Organics Pathway Total					2.3E-08	2.9E-07	1.0E-12	3.1E-07	
Pathway Total - Chemicals					1.4E-07	6.3E-07	8.9E-10	7.7E-07	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
ILCR = Incremental lifetime cancer risk.

Table A-11. Adult Trespasser Shallow Surface Soil (0-1 ft BGS) Non-Carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	3.3E-04	8.9E-05	7.0E-08	3.3E-04	8.9E-05	4.9E-05	4.6E-04	
Antimony	8.0E+00	1.9E-07	5.3E-08	4.2E-11	4.9E-04	8.9E-04		1.4E-03	
Arsenic	1.1E+01	2.6E-07	2.2E-06	5.7E-11	8.8E-04	7.2E-03		8.1E-03	
Barium	2.5E+02	6.0E-06	1.7E-06	1.3E-09	8.6E-05	3.4E-04	9.2E-06	4.3E-04	
Cadmium	1.8E+00	4.3E-08	1.2E-08	9.3E-12	4.3E-05	4.7E-04		5.1E-04	
Chromium	2.3E+01	5.6E-07	1.5E-07	1.2E-10	1.9E-04	2.0E-03	4.2E-06	2.2E-03	
Copper	8.2E+01	2.0E-06	5.5E-07	4.4E-10	5.0E-05	1.4E-05		6.4E-05	
Manganese	8.0E+02	2.0E-05	5.4E-06	4.3E-09	4.3E-04	2.9E-03	3.0E-04	3.7E-03	
Vanadium	2.1E+01	5.0E-07	1.4E-07	1.1E-10	7.2E-05	7.6E-04		8.3E-04	
Zinc	5.7E+02	1.4E-05	3.8E-06	3.0E-09	4.7E-05	4.2E-05		8.9E-05	
Inorganics Pathway Total					2.6E-03	1.5E-02	3.6E-04	1.8E-02	
2,4,6-Trinitrotoluene	4.8E-01	1.2E-08	3.2E-07	2.5E-12	2.3E-05	6.4E-04		6.7E-04	
Benz(a)anthracene	3.2E-01	7.8E-09	2.8E-07	1.7E-12					
Benzo(a)pyrene	3.2E-01	7.9E-09	2.8E-07	1.7E-12					
Benzo(b)fluoranthene	4.2E-01	1.0E-08	3.6E-07	2.2E-12					
Indeno(1,2,3-cd)pyrene	3.0E-01	7.4E-09	2.6E-07	1.6E-12					
Organics Pathway Total					2.3E-05	6.4E-04		6.7E-04	
Pathway Total - Chemicals					2.6E-03	1.5E-02	3.6E-04	1.8E-02	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.

Table A-12. Adult Trespasser Shallow Surface Soil (0-1 ft BGS) Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	1.4E-04	3.8E-05	3.0E-08					
Antimony	8.0E+00	8.3E-08	2.3E-08	1.8E-11					
Arsenic	1.1E+01	1.1E-07	9.3E-07	2.5E-11	1.7E-07	1.4E-06	3.7E-10	1.6E-06	R
Barium	2.5E+02	2.6E-06	7.1E-07	5.6E-10					
Cadmium	1.8E+00	1.8E-08	5.0E-09	4.0E-12			2.5E-11	2.5E-11	
Chromium	2.3E+01	2.4E-07	6.5E-08	5.2E-11			2.2E-09	2.2E-09	
Copper	8.2E+01	8.6E-07	2.4E-07	1.9E-10					
Manganese	8.0E+02	8.4E-06	2.3E-06	1.8E-09					
Vanadium	2.1E+01	2.2E-07	5.9E-08	4.7E-11					
Zinc	5.7E+02	6.0E-06	1.6E-06	1.3E-09					
Inorganics Pathway Total					1.7E-07	1.4E-06	2.6E-09	1.6E-06	
2,4,6-Trinitrotoluene	4.8E-01	5.0E-09	1.4E-07	1.1E-12	1.5E-10	4.1E-09		4.3E-09	
Benz(a)anthracene	3.2E-01	3.3E-09	1.2E-07	7.2E-13	2.4E-09	8.7E-08	2.2E-13	8.9E-08	
Benzo(a)pyrene	3.2E-01	3.4E-09	1.2E-07	7.3E-13	2.5E-08	8.8E-07	2.3E-12	9.0E-07	
Benzo(b)fluoranthene	4.2E-01	4.4E-09	1.6E-07	9.5E-13	3.2E-09	1.1E-07	2.9E-13	1.2E-07	
Indeno(1,2,3-cd)pyrene	3.0E-01	3.2E-09	1.1E-07	6.8E-13	2.3E-09	8.2E-08	2.1E-13	8.4E-08	
Organics Pathway Total					3.3E-08	1.2E-06	3.0E-12	1.2E-06	
Pathway Total - Chemicals					2.0E-07	2.6E-06	2.6E-09	2.8E-06	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
ILCR = Incremental lifetime cancer risk.

Table A-13. Juvenile Trespasser Sediment Non-carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	6.5E-04	6.4E-05	7.1E-08	6.5E-04	6.4E-05	5.0E-05	7.7E-04	
Antimony	1.6E+02	7.9E-06	7.7E-07	8.6E-10	2.0E-02	1.3E-02		3.3E-02	
Arsenic	1.4E+01	7.1E-07	2.1E-06	7.7E-11	2.4E-03	6.9E-03		9.3E-03	
Barium	3.2E+02	1.6E-05	1.6E-06	1.7E-09	2.3E-04	3.2E-04	1.2E-05	5.6E-04	
Cadmium	3.5E+00	1.8E-07	1.7E-08	1.9E-11	1.8E-04	7.0E-04		8.8E-04	
Chromium	3.8E+01	1.9E-06	1.9E-07	2.1E-10	6.5E-04	2.5E-03	7.4E-06	3.2E-03	
Copper	1.5E+02	7.6E-06	7.4E-07	8.2E-10	1.9E-04	1.8E-05		2.1E-04	
Manganese	5.6E+02	2.9E-05	2.8E-06	3.1E-09	6.2E-04	1.5E-03	2.2E-04	2.4E-03	
Nickel	3.3E+01	1.7E-06	1.7E-07	1.8E-10	8.4E-05	2.1E-04		2.9E-04	
Vanadium	2.3E+01	1.2E-06	1.1E-07	1.3E-10	1.7E-04	6.2E-04		7.9E-04	
Zinc	1.5E+03	7.5E-05	7.3E-06	8.1E-09	2.5E-04	8.1E-05		3.3E-04	
Inorganics Pathway Total					2.5E-02	2.6E-02	2.9E-04	5.1E-02	
2,4,6-Trinitrotoluene	3.0E+00	1.5E-07	1.5E-06	1.6E-11	3.0E-04	2.9E-03		3.2E-03	
Benzo(b)fluoranthene	6.4E-01	3.3E-08	4.2E-07	3.5E-12					
Organics Pathway Total					3.0E-04	2.9E-03		3.2E-03	
Pathway Total - Chemicals					2.5E-02	2.9E-02	2.9E-04	5.5E-02	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituent of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.

Table A-14. Juvenile Trespasser Sediment Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	9.3E-05	9.1E-06	1.0E-08					
Antimony	1.6E+02	1.1E-06	1.1E-07	1.2E-10					
Arsenic	1.4E+01	1.0E-07	3.0E-07	1.1E-11	1.5E-07	4.5E-07	1.7E-10	6.0E-07	
Barium	3.2E+02	2.3E-06	2.2E-07	2.5E-10					
Cadmium	3.5E+00	2.6E-08	2.5E-09	2.8E-12			1.7E-11	1.7E-11	
Chromium	3.8E+01	2.8E-07	2.7E-08	3.0E-11			1.3E-09	1.3E-09	
Copper	1.5E+02	1.1E-06	1.1E-07	1.2E-10					
Manganese	5.6E+02	4.1E-06	4.0E-07	4.4E-10					
Nickel	3.3E+01	2.4E-07	2.4E-08	2.6E-11					
Vanadium	2.3E+01	1.7E-07	1.6E-08	1.8E-11					
Zinc	1.5E+03	1.1E-05	1.0E-06	1.2E-09					
Inorganics Pathway Total					1.5E-07	4.5E-07	1.4E-09	6.0E-07	
2,4,6-Trinitrotoluene	3.0E+00	2.1E-08	2.1E-07	2.3E-12	6.4E-10	6.3E-09		6.9E-09	
Benzo(b)fluoranthene	6.4E-01	4.7E-09	5.9E-08	5.1E-13	3.4E-09	4.3E-08	1.6E-13	4.7E-08	
Organics Pathway Total					4.0E-09	5.0E-08	1.6E-13	5.4E-08	
Pathway Total - Chemicals					1.6E-07	5.0E-07	1.4E-09	6.5E-07	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituents of potential concern.
EPC = Exposure point concentration.
ILCR = Incremental lifetime cancer risk.

Table A-15. Adult Trespasser Sediment Non-carcinogenic Hazards - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	3.2E-04	8.6E-05	6.8E-08	3.2E-04	8.6E-05	4.8E-05	4.5E-04	
Antimony	1.6E+02	3.8E-06	1.0E-06	8.3E-10	9.5E-03	1.7E-02		2.7E-02	
Arsenic	1.4E+01	3.4E-07	2.8E-06	7.4E-11	1.1E-03	9.4E-03		1.1E-02	
Barium	3.2E+02	7.7E-06	2.1E-06	1.7E-09	1.1E-04	4.3E-04	1.2E-05	5.5E-04	
Cadmium	3.5E+00	8.6E-08	2.4E-08	1.9E-11	8.6E-05	9.4E-04		1.0E-03	
Chromium	3.8E+01	9.4E-07	2.6E-07	2.0E-10	3.1E-04	3.4E-03	7.1E-06	3.7E-03	
Copper	1.5E+02	3.6E-06	1.0E-06	7.9E-10	9.1E-05	2.5E-05		1.2E-04	
Manganese	5.6E+02	1.4E-05	3.8E-06	3.0E-09	3.0E-04	2.0E-03	2.1E-04	2.6E-03	
Nickel	3.3E+01	8.1E-07	2.2E-07	1.8E-10	4.1E-05	2.8E-04		3.2E-04	
Vanadium	2.3E+01	5.6E-07	1.5E-07	1.2E-10	8.0E-05	8.4E-04		9.2E-04	
Zinc	1.5E+03	3.6E-05	9.8E-06	7.8E-09	1.2E-04	1.1E-04		2.3E-04	
Inorganics Pathway Total					1.2E-02	3.5E-02	2.8E-04	4.7E-02	
2,4,6-Trinitrotoluene	3.0E+00	7.2E-08	2.0E-06	1.6E-11	1.4E-04	3.9E-03		4.1E-03	
Benzo(b)fluoranthene	6.4E-01	1.6E-08	5.6E-07	3.4E-12					
Organics Pathway Total					1.4E-04	3.9E-03		4.1E-03	
Pathway Total - Chemicals					1.2E-02	3.9E-02	2.8E-04	5.1E-02	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituents of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.

Table A-16. Adult Trespasser Sediment Carcinogenic Risks - Direct Contact

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	1.3E+04	1.4E-04	3.7E-05	2.9E-08					
Antimony	1.6E+02	1.6E-06	4.5E-07	3.5E-10					
Arsenic	1.4E+01	1.5E-07	1.2E-06	3.2E-11	2.2E-07	1.8E-06	4.8E-10	2.0E-06	R
Barium	3.2E+02	3.3E-06	9.0E-07	7.2E-10					
Cadmium	3.5E+00	3.7E-08	1.0E-08	8.0E-12			5.0E-11	5.0E-11	
Chromium	3.8E+01	4.0E-07	1.1E-07	8.7E-11			3.7E-09	3.7E-09	
Copper	1.5E+02	1.6E-06	4.3E-07	3.4E-10					
Manganese	5.6E+02	5.9E-06	1.6E-06	1.3E-09					
Nickel	3.3E+01	3.5E-07	9.6E-08	7.6E-11					
Vanadium	2.3E+01	2.4E-07	6.5E-08	5.2E-11					
Zinc	1.5E+03	1.5E-05	4.2E-06	3.3E-09					
Inorganics Pathway Total					2.2E-07	1.8E-06	4.2E-09	2.0E-06	
2,4,6-Trinitrotoluene	3.0E+00	3.1E-08	8.5E-07	6.7E-12	9.3E-10	2.5E-08		2.6E-08	
Benzo(b)fluoranthene	6.4E-01	6.8E-09	2.4E-07	1.5E-12	4.9E-09	1.8E-07	4.5E-13	1.8E-07	
Organics Pathway Total					5.9E-09	2.0E-07	4.5E-13	2.1E-07	
Pathway Total - Chemicals					2.3E-07	2.0E-06	4.2E-09	2.2E-06	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituents of potential concern.
EPC = Exposure point concentration.
ILCR = Incremental lifetime cancer risk.

Table A-17. Juvenile Trespasser Surface Water Non-Carcinogenic Hazards - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d)		Hazard Quotient (HQ)		Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Ingestion	Dermal		
EBG							
Aluminum	2.9E+01	8.9E-03	3.1E-03	8.9E-03	3.1E-03	1.2E-02	
Antimony	1.1E-02	3.4E-06	6.0E-07	8.4E-03	1.0E-02	1.8E-02	
Arsenic	7.2E-02	2.2E-05	6.9E-06	7.3E-02	2.3E-02	9.6E-02	
Cadmium	4.0E-03	1.2E-06	6.9E-08	2.4E-03	2.7E-03	5.1E-03	
Chromium	3.7E-02	1.1E-05	1.9E-06	3.8E-03	2.5E-02	2.8E-02	
Manganese	9.9E+00	3.0E-03	6.3E-04	6.6E-02	3.4E-01	4.1E-01	
Vanadium	5.7E-02	1.7E-05	3.8E-06	2.5E-03	2.1E-02	2.3E-02	
Inorganics Pathway Total				1.7E-01	4.3E-01	5.9E-01	
Chloroform	7.1E-04	2.2E-07	3.1E-07	2.2E-05	3.1E-05	5.3E-05	
Organics Pathway Total				2.2E-05	3.1E-05	5.3E-05	
Pathway Total - Chemicals				1.7E-01	4.3E-01	5.9E-01	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituents of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.

Table A-18. Juvenile Trespasser Surface Water Carcinogenic Risks - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d)		Risk		Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Ingestion	Dermal		
EBG							
Aluminum	2.9E+01	1.3E-03	4.5E-04				
Antimony	1.1E-02	4.8E-07	8.6E-08				
Arsenic	7.2E-02	3.1E-06	9.9E-07	4.7E-06	1.5E-06	6.2E-06	R
Cadmium	4.0E-03	1.7E-07	9.8E-09				
Chromium	3.7E-02	1.6E-06	2.6E-07				
Manganese	9.9E+00	4.3E-04	9.0E-05				
Vanadium	5.7E-02	2.5E-06	5.4E-07				
Inorganics Pathway Total				4.7E-06	1.5E-06	6.2E-06	
Chloroform	7.1E-04	3.1E-08	4.5E-08	1.9E-10	2.7E-10	4.6E-10	
Organics Pathway Total				1.9E-10	2.7E-10	4.6E-10	
Pathway Total - Chemicals				4.7E-06	1.5E-06	6.2E-06	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituents of potential concern.
EPC = Exposure point concentration.
ILCR = Incremental lifetime cancer risk.

Table A-19. Adult Trespasser Surface Water Non-Carcinogenic Hazards - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d)			Hazard Quotient (HQ)			Total HI Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	2.9E+01	8.6E-03	2.1E-03		8.6E-03	2.1E-03		1.1E-02	
Antimony	1.1E-02	3.3E-06	4.0E-07		8.1E-03	6.7E-03		1.5E-02	
Arsenic	7.2E-02	2.1E-05	4.7E-06		7.1E-02	1.6E-02		8.6E-02	
Cadmium	4.0E-03	1.2E-06	4.6E-08		2.3E-03	1.9E-03		4.2E-03	
Chromium	3.7E-02	1.1E-05	1.2E-06		3.6E-03	1.7E-02		2.0E-02	
Manganese	9.9E+00	2.9E-03	4.2E-04		6.3E-02	2.3E-01		2.9E-01	
Vanadium	5.7E-02	1.7E-05	2.6E-06		2.4E-03	1.4E-02		1.6E-02	
Inorganics Pathway Total					1.6E-01	2.9E-01		4.5E-01	
Chloroform	7.1E-04	2.1E-07	2.1E-07		2.1E-05	2.1E-05		4.2E-05	
Organics Pathway Total					2.1E-05	2.1E-05		4.2E-05	
Pathway Total - Chemicals					1.6E-01	2.9E-01		4.5E-01	

[a] COPCs are identified as constituents of concern (COCs) if the total HI across all pathways is > 1 (H).
COPC = Constituents of potential concern.
EPC = Exposure point concentration.
HI = Hazard index.

Table A-20. Adult Trespasser Surface Water Carcinogenic Risks - Direct Contact

COPC	EPC (mg/L)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
EBG									
Aluminum	2.9E+01	3.7E-03	9.0E-04						
Antimony	1.1E-02	1.4E-06	1.7E-07						
Arsenic	7.2E-02	9.1E-06	2.0E-06		1.4E-05	3.0E-06		1.7E-05	R
Cadmium	4.0E-03	5.0E-07	2.0E-08						
Chromium	3.7E-02	4.7E-06	5.3E-07						
Manganese	9.9E+00	1.2E-03	1.8E-04						
Vanadium	5.7E-02	7.1E-06	1.1E-06						
Inorganics Pathway Total					1.4E-05	3.0E-06		1.7E-05	
Chloroform	7.1E-04	8.9E-08	9.1E-08		5.4E-10	5.5E-10		1.1E-09	
Organics Pathway Total					5.4E-10	5.5E-10		1.1E-09	
Pathway Total - Chemicals					1.4E-05	3.0E-06		1.7E-05	

[a] COPCs are identified as constituents of concern (COCs) if the total ILCR across all pathways is > 1E-06 (R).
COPC = Constituents of potential concern.
EPC = Exposure point concentration.
ILCR = Incremental lifetime cancer risk.

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