FINAL

FEASIBILITY STUDY
for Ramsdell Quarry Landfill

(RVAAP-01)

Ravenna Army Ammunition Plant
Ravenna, Ohio

October 2006

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

US Army Corps of Engineers®
Louisville District

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
ARAR	Applicable and Relevant or Appropriate Requirements
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
BGS	below ground surface
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CMCOC	contaminant migration chemical of concern
CMCOPC	contaminant migration chemical of potential concern
COC	constituent of concern
COEC	constituent of ecological concern
COPEC	constituent of potential ecological concern
COPC	constituent of potential concern
cPAH	carcinogenic polycyclic hydrocarbon
CSF	cancer slope factor
CTT	closed, transferring, and transferred
DERR	Division of Emergency and Remedial Response
DFFO	Director's Final Findings and Orders
DNB	dinitrobenzene
DNT	dinitrotoluene
DoD	U. S. Department of Defense
DOT	U. S. Department of transportation
EPC	exposure point concentration
ERA	ecological risk assessment
ESA	Endangered Species Act
ESV	ecological screening value
FRTR	Federal Remediation Technologies Roundtable
FS	Feasibility Study
FSCOC	feasibility study constituent of concern
FWHHRAM	Facility Wide Human Health Risk Assessor Manual
GAF	gastrointestinal absorption factor
GRA	general response actions
GSA	U. S. General Services Administration
HI	hazard index
HHRA	human health risk assessment
HQ	hazard quotient
ILCR	incremental lifetime cancer risk

LIST OF ACRONYMS (CONTINUED)

IEUBK	Integrated Exposure Uptake Biokinetic
IRP	Installation Restoration Program
LDR	land disposal requirement
MCL	maximum contaminant level
MEC	munitions and explosives of concern
MDC	maximum detected concentration
MMRP	Military Munitions Response Program
MNA	monitored natural attenuation
MTR	minimum technical requirements
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NGB	National Guard Bureau
O&M	operation and maintenance
OAC	Ohio Administrative Code
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
PAH	polycyclic aromatic hydrocarbon
PBC	Performance Based Contract
PBT	persistent, bioaccumulative, and toxic
PCB	polychlorinated biphenyl
PP	Proposed Plan
PPE	personal protective equipment
PRG	preliminary remediation goal
PWS	Performance Work Statement
RAB	Restoration Advisory Board
RAGS	Risk Assessment Guidance for Superfund
RAO	Remedial Action Objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RD	Remedial Design
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
RQL	Ramsdell Quarry Landfill
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
SAIC	Science Applications International Corporation

LIST OF ACRONYMS (CONTINUED)

SERA	Screening Ecological Risk Assessment
SESOIL	Seasonal Soil Compartment Model
SDMP	Scientific decision management point
SRC	site-related contaminant
S/S	stabilization/solidification
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TEF	toxicity equivalent factor
TERP	Transportation and Emergency Response Plan
THI	target hazard index
TNT	Trinitrotoluene
TR	target risk
TU	temporary unit
UHC	underlying hazardous constituent
USACE	U. S. Army Corps of Engineers
USEPA	U. S. Environmental Protection Agency
USGS	U. S. Geological Society
UTS	universal treatment standards
VOC	volatile organic compound
WQC	water quality criteria

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 Ramsdell Quarry Landfill (RQL) (RVAAP-01). RQL 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 RQL Remedial Investigation (RI) phase is complete. The RI phase of work indicates evidence of impacts that require further evaluation in a Feasibility Study (FS). This report documents the FS for soil and dry sediment media at RQL in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980.

ES.1 SCOPE

This FS evaluates CERCLA remediation alternatives to achieve remedy for soils and dry sediments at RQL. Remediation with respect to aqueous media (i.e., groundwater, surface water, and wet sediments) is not included in this FS and will be addressed under future decisions. However, remedies for soils and dry sediment are evaluated to ensure they are protective of groundwater with respect to the anticipated future land use. Remedies for soils and dry sediments also incorporate the necessary engineering controls to ensure protectiveness of surface water during implementation.

ES.2 SUMMARY OF REMEDIAL ACTION OBJECTIVES

Remedial Action Objectives (RAOs) specify the requirements remedial alternatives must fulfill to protect human health and the environment from site-related contaminants (SRCs) at RQL. To provide this protection, media-specific objectives that identify major contaminants and associated media-specific cleanup goals are developed. The RAOs specify constituents of concern (COCs), exposure routes and receptors, and acceptable constituent concentrations for long-term protection of receptors.

A portion of RQL is occupied by a closed landfill regulated under Ohio solid waste regulations. Additionally, operational history of the AOC indicates the potential for munitions and explosives of concern (MEC) at the AOC, which will be addressed under the Military Munitions Response Program (MMRP).

Based on these considerations, land use for RQL under a restricted (military mission) use will be controlled and a Security Guard/Maintenance Worker is evaluated as the most likely receptor under a restricted land use scenario. A residential land use scenario is also evaluated to provide a full comparative range of alternatives; however, due to the considerations noted above, this land use is not considered a reasonable and foreseeable land use at the current time. Table ES-1 lists the receptor for each land use scenario at RQL.

Table ES-1. Land Use Scenarios Assessed in the RQL FS

Area of Concern	Land Use Scenario	Receptor
RQL	Restricted	Security Guard/Maintenance Worker
	Residential	Resident Subsistence Farmer

Based on the reasonable and foreseeable land use at RQL, the following RAO is developed for contaminated soils and dry sediments at RQL:

- Prevent Security Guard/Maintenance Worker exposure to contaminants in soils and dry sediments which exceed risk-based cleanup goals to a depth of 1 ft below ground surface (BGS).

ES.2.1 Identification of Human Health Preliminary Cleanup Goals for RQL

Preliminary cleanup goals were developed to support the remedial alternative selection process for soil remediation at RQL. Preliminary cleanup goals are the chemical-specific, risk-based values used to meet the remedial action objective for protection of human health. A summary of the preliminary cleanup goals for the COCs identified for evaluation of remedial alternatives is provided below and in Table ES-2 for the Security Guard/Maintenance Worker and Resident Subsistence Farmer land use.

Table ES-2. Summary of COCs and Preliminary Cleanup Goals for Evaluation of Remedial Alternatives for RQL

COC	Preliminary Cleanup Goal (mg/kg)			
	Soil	Sediment	Surface Water	Groundwater
Representative Land Use (Restricted Access – Security Guard/Maintenance Worker)				
Benz(a)anthracene	13	--	--	--
Benzo(a)pyrene	1.3	--	--	--
Benzo(b)fluoranthene	13	--	--	--
Dibenz(a,h)anthracene	1.3	--	--	--
Indeno(1,2,3-cd)pyrene	13	--	--	--
Residential Land Use (Resident Subsistence Farmer)				
Lead	400	--	--	--
Benz(a)anthracene	5.9	--	--	--
Benzo(a)pyrene	0.59	--	--	--
Benzo(b)fluoranthene	5.9	--	--	--
Benzo(k)fluoranthene	59	--	--	--
Dibenz(a,h)anthracene	0.59	--	--	--
Indeno(1,2,3-cd)pyrene	5.9	--	--	--

-- = Chemical is not a COC for evaluation of remedial alternatives in this FS for this medium.
COC = Constituent of concern.
FS = Feasibility Study.

ES.2.2 Ecological Preliminary Cleanup Goals for RQL

The Ecological Risk Assessment (ERA) performed for RQL is available in the RI Report and summarized in Chapter 2 of this FS. Ohio Environmental Protection Agency (Ohio EPA) Level I and II protocols were performed for RQL and show a number of exceedances of observed concentrations compared to Ecological Screening Value (ESVs). The ERA in the RQL RI Report identifies a variety of ecological receptor populations that could be at risk and identifies the constituents of potential ecological concern (COPECs) and constituents of ecological concern (COECs) that could contribute to potential risks from exposure to contaminated media.

It is recommended that no quantitative preliminary cleanup goals to protect ecological receptors be developed at RQL. 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 weight-of-evidence conclusions:

- Field observations (Level I of the Ohio EPA protocols and Ohio Rapid Assessment for Wetlands) indicate there are currently few adverse ecological effects (USACE 2005b), and there is ample nearby habitat to maintain ecological communities at RQL and elsewhere on RVAAP. These observations imply that remediation to protect ecological resources is not necessary.

- The extent of contamination is very limited and, therefore, is not expected to impact ecological resources such as populations and communities.

- Remediation of soils and dry sediments to meet human health goals will further reduce already low ecological risks.

Additional information about the dual protectiveness of human health and ecological resources is found in the overall protectiveness rows of Table 7-1.

ES.2.3 Extent and Volume Calculations

Estimated volumes of impacted soils and dry sediments at RQL where COCs above preliminary cleanup goals were identified for further evaluation in the FS. Analytical data collected during the remedial investigations were used to generate a three dimensional volume model for each final AOC-related COC using a geologic modeling and geospatial visualization program. The volumes exceeding preliminary cleanup goals for Security Guard/Maintenance Worker and Resident Subsistence Farmer land use are summarized in Table ES-3.

Table ES-3. Estimated Volume of Impacted Soils

AOC/Scenario	Surface Area (ft^2)	In situ		In situ with Constructability[a]		Ex situ[a,b]	
		Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
RQL Security Guard/Maintenance Worker Land Use – Soil	7,621	7,621	282	9,526	353	11,432	423
RQL Resident Subsistence Farmer Land Use – Soil	14,683	14,683	543	18,354	679	22,025	815

[a] Includes 25% constructability factor.
[b] Includes 20% swell factor.
AOC = Area of concern.
RQL = Ramsdell Quarry Landfill.

ES.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Remedial alternatives (presented in Table ES-4) were assembled for impacted soils at RQL. The remedial alternatives were constructed by combining general response actions, technology types, and process options retained from the screening processes. Remedial alternatives should assure adequate protection of human health and the environment, achieve RAOs, meet Applicable and Relevant or Appropriate Requirements (ARARs), and permanently and significantly reduce the volume, toxicity, and/or mobility of COCs.

ES.4 RECOMMENDED ALTERNATIVE

The Recommended Alternative for RQL is Alternative 3 (Excavation of Soils and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use). This alternative involves the removal of soils at RQL that exceed preliminary cleanup goals for the Security Guard/Maintenance Worker at locations RQL-025 and RQL-026. MI confirmation sampling will be conducted for 1) hotspot removal areas to confirm preliminary cleanup goals have been achieved and 2) soil/dry sediment media in other areas of the quarry bottom previously sampled using MI sampling methods in the Phase I RI. This confirmation sampling will dictate whether additional land use controls or further removal of soil/dry sediment is required.

Assuming removal beyond the extent of the RQL-025 and RQL-026 hotspot areas is not needed, the cost for the alternative is estimated to be $301,978.Following the removal, land use controls and 5-year reviews will be necessary to restrict access to RQL. Access restrictions are already being implemented at RQL and reinforcement of these controls will bolster the protectiveness of Alternative 3.

Table ES-4. Summary of Remedial Alternatives

Alternative 1 – No Action This remedial alternative provides no further remedial action and is included as a baseline for comparison with other remedial alternatives. Access restrictions and environmental monitoring would be discontinued. The AOC will no longer have legal, physical, or administrative mechanisms to restrict AOC access. Additional actions regarding monitoring or access restrictions will not be implemented. 5-year reviews would not be conducted in accordance with CERCLA 121(c).
Alternative 2 – Limited Action This remedial alternative involves the implementation of land use controls and periodic monitoring (i.e., 5-year reviews) to detect any changes in the nature or extent of contamination at the AOC. Land use controls (e.g., administrative access and land use restrictions; warning and informational signs, no use of groundwater) would be developed and implemented by the US Army and Ohio Army National Guard. Current land use controls with respect to maintenance of the closed landfill would continue to be implemented by the US Army. 5-year reviews would be conducted in accordance with CERCLA 121(c) to ensure the remedy remains protective.
Alternative 3 – Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soils/dry sediments above Security Guard/Maintenance Worker land use preliminary cleanup goals for offsite disposal. Impacted soils/dry sediments would be excavated and transported to an offsite disposal facility licensed and permitted to accept these wastes. Confirmation sampling would be conducted to 1) ensure Security Guard/Maintenance Worker land use preliminary cleanup goals have been achieved at the hotspot removal areas and 2) verify the remaining soil/dry sediment in other areas of the quarry bottom does not exceed preliminary cleanup goals. Areas successfully remediated would be backfilled with clean soils, if appropriate. In addition to closure requirements for the landfill, land use controls may include continuing existing access restrictions; prohibiting changes in land uses; and conducting periodic inspection of the AOC to determine land use changes. Periodic environmental monitoring (i.e., groundwater) would be conducted to confirm no impacts to groundwater. The remedial action includes an O&M period. 5-year reviews would be conducted in accordance with CERCLA 121(c).
Alternative 4 – Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soil/dry sediment above Resident Subsistence Farmer land use preliminary cleanup goals for offsite disposal. Impacted soils/dry sediments would be excavated and transported to an offsite disposal facility licensed and permitted to accept these wastes. Confirmation sampling would be conducted to 1) ensure Resident Subsistence Farmer land use preliminary cleanup goals have been achieved at hotspot removal areas and 2) verify the remaining soil/dry sediment in other areas of the quarry bottom does not exceed preliminary cleanup goals. Areas successfully remediated would be backfilled with clean soils, as appropriate. Periodic environmental monitoring (i.e., surface water and groundwater) would be conducted under the facility-wide monitoring programs. Alternative 4 does not include O&M as residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative. Sampling and access restrictions may be required because of the existing closed landfill.

AOC = Area of concern.
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
O&M = Operation and maintenance.

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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 the six high priority areas of concern (AOCs) at the Ravenna Army Ammunition Plant (RVAAP) in Ravenna, Ohio by September 30, 2007:

- RVAAP-01 Ramsdell Quarry Landfill (RQL);
- RVAAP-02 Erie Burning Grounds;
- RVAAP-04 Open Demolition Area #2;
- RVAAP-12 Load Line 12;
- RVAAP-16 Fuze and Booster Quarry Landfill/Ponds; and
- RVAAP-49 Central Burn Pits.

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] 2004).

1.1 PURPOSE

This Feasibility Study (FS) evaluates remediation alternatives to achieve remedy for soils and dry sediments at RQL. Remediation of impacts to aqueous media (groundwater, surface water, and wet sediment) are not included under the scope of this FS. Groundwater and surface water media are to be addressed under future decisions. The following steps summarize the process supporting development and implementation of remedies for soil at the six high priority AOCs:

1. Complete Remedial Investigation (RI) Reports;
2. Complete FSs and Reports;
3. Prepare Proposed Plan(s) (PP);
4. Prepare Record of Decision(s) (ROD);
5. Prepare Remedial Design (RD) Work Plans;
6. Implement the RD Work Plans; and
7. Prepare Remedial Action Completion Reports.

The RQL RI phase is complete. The RI phase of work indicates evidence of impacts that requires further evaluation in a FS. This report documents the FS for soil and dry sediment media at RQL in compliance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980.

This FS evaluates a range of remedial actions to reduce risks to the environment and human health at RQL in accordance with remedial action objectives (RAOs) and to obtain remedy for (or cleanup of) soils and dry sediments. The remedial activities include no action, limited action, and removal of soils/dry sediments. RAO is developed in the FS to protect receptors from impacted environmental media and constituents of concern (COCs) identified in the RQL RI Report (USACE 2005b). Alternatives for remediation of impacted soils and dry sediments are presented and evaluated. Applicable and relevant or appropriate requirements (ARARs) also are identified.

Depending on the outcome of the evaluation in this FS, a preferred alternative will be submitted for public review and comment in a PP. The preferred alternative will be documented in a PP for public review and comment. Public comments will be considered in the final selection of a remedy, which will be documented in a ROD. Responses to public comments will be addressed in the responsiveness summary of the ROD.

1.2 SCOPE

This FS evaluates necessary CERCLA remediation requirements for chemical contamination in soils and dry sediment to achieve remedy at RQL. In addition, residual soils are evaluated to demonstrate that the evaluated remedy is protective of groundwater at RQL with respect to the anticipated future land uses. Remediation of aqueous media (i.e., groundwater, surface water, and wet sediments) is not included in this FS. Remedies for soils and dry sediments also incorporate the necessary land use controls during implementation to ensure protectiveness of surface water during implementation.

Ohio Army National Guard (OHARNG) has established future land uses at RQL based on anticipated training mission and utilization of the Ravenna Training and Logistics Site (RTLS) (USACE 2005b). These anticipated future land uses, in conjunction with the evaluation of residential land use and associated receptors, form the basis for identifying and evaluating remedial alternatives in this FS.

In addition, the following features are not included in the scope of this FS:

- Closure of the permitted sanitary landfill at RQL was completed in May 1990 under state of Ohio solid waste regulations [Ohio Administrative Code (OAC) 3745-27-10]. Future post-closure monitoring requirements were transferred to the Facility-Wide Groundwater Monitoring Plan when the DFFO was issued on June 10, 2004 (Ohio EPA 2004a). The FS addresses the contaminant occurrence and distribution, if any, in surface soil within the bottom of the quarry. The evaluation of preliminary remedial goals and subsequent evaluated alternatives for this FS does not encompass the former RQL landfill operation (see Figure 2-3). The closed landfill currently has land use controls and monitoring requirements (classified as "Restricted Access" and undergoes semi-annual monitoring of five monitoring wells). The Recommended Alternative will not pertain to the former landfill portion of RQL.

- Removal actions specifically addressing munitions and explosives of concern (MEC) issues or the potential environmental impact from any future MEC removal. In 2001, the U. S.

Department of Defense (DoD) established the Military Munitions Response Program (MMRP) to manage the environmental, health, and safety issues presented by MEC as a result of historical activities at a site. An inventory of the closed, transferring, and transferred (CTT) ranges or AOCs at RVAAP completed in November 2003 identified 19 MMRP AOCs at RVAAP that are known or suspected to contain MEC, including RQL.

This FS contains an evaluation of a trespasser scenario in addition to the anticipated current/future receptors identified in the RVAAP Facility-Wide Human Health Risk Assessment Manual (FWHHRAM; USACE 2004) [i.e., National Guard Trainee, National Guard Dust/Fire Control Worker, Security Guard/Maintenance Worker, Hunter/Trapper/Fisher, and Resident Subsistence Farmer (adult and child)]. An Adult and Juvenile Trespasser scenario was evaluated to supplement the baseline human health risk assessment (HHRA) detailed in the RI Report (USACE 2005b) per the FWHHRAM Amendment #1 (USACE 2005c) to provide risk managers with information to support determination of the need for continued security at the facility.

1.3 REPORT ORGANIZATION

The organization of this report is based on the U. S. Environmental Protection Agency (USEPA) guidance and includes ten major sections. This report presents the findings of the FS conducted for RQL and is organized as follows:

- Chapter 2: Background Information;
- Chapter 3: Remedial Action Objectives;
- Chapter 4: Applicable or Relevant and Appropriate Requirements;
- Chapter 5: Technology Types and Process Options;
- Chapter 6: Development of Remedial Alternatives;
- Chapter 7: Analysis of Remedial Alternatives;
- Chapter 8: Agency Coordination and Public Involvement;
- Chapter 9: Conclusions; and
- Chapter 10: References.

Chapter 2 summarizes facility and background information. Chapter 3 outlines the development of RAOs for the constituents and media of concern. Chapter 4 presents the ARARs. Chapter 5 reviews the identification and screening of technology types and process options considered for possible use in remediation. Chapter 6 develops the proposed remedial alternatives, which are analyzed in detail in Chapter 7. Chapter 8 summarizes partnering and public involvement activities. Chapter 9 presents conclusions. References are found in Chapter 10, followed by the appendices. The appendices provide information supporting the evaluations presented in the body of this FS Report:

- Appendix 2: Evaluation of trespasser (adult and juvenile) exposure scenario;
- Appendix 3A: Contaminant fate and transport assessment;
- Appendix 3B: Volume estimates of impacted soils; and
- Appendix 7: Detailed cost estimates.

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2.0 BACKGROUND INFORMATION

2.1 FACILITY-WIDE BACKGROUND INFORMATION

2.1.1 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 OHARNG over a 2-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 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 2-1 and 2-2). 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 RVAAP in this document are considered to be inclusive of the historical extent of 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 2,4,6-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 AOCs at RVAAP 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.

2.1.2 Demography and Land Use

RVAAP consists of 8,775 ha (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.

2.1.3 RVAAP Physiographic Setting

RVAAP is located within the Southern New York Section of the Appalachian Plateau physiographic province (U. S. Geological Society [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 RAMSDELL QUARRY LANDFILL

2.2.1 RQL History

RQL is approximately 14 acres in size and located in the northeastern part of the RVAAP facility (Figure 2-2). The quarry at RQL is approximately 10 acres in size, and has an intermittent pond that has been observed to be dry for extended periods (Figure 2-3 and Photograph 2-1). The quarry was in operation until 1941. During that time, it was excavated to 9 to 12 m (30 to 40 ft) below existing grade. The excavated sandstone and quartzite pebble conglomerate was used for road and construction ballast. From 1946 to the 1950s, the bottom of the quarry was used to burn waste explosives from Load Line 1. Reportedly, 18,000 225-kg (500-lb) incendiary or napalm bombs were burned and liquid residues from annealing operations were disposed of in the quarry.

Between 1941 and 1989 the western and southern sections of the abandoned quarry were used for landfill operations. No information is available regarding landfill disposal activities from 1941 to 1976, and no information is available on other activities at the quarry from the 1950s to 1976. Solid waste materials were disposed of in RQL from 1976 until it was closed in 1989. In 1978, a portion of the abandoned quarry was permitted as a sanitary landfill by the state of Ohio. The sanitary landfill was closed in 1990 under state of Ohio solid waste regulations. The RQL cap on the former permitted landfill covers approximately 4 acres of RQL. The installation and semi-annual monitoring of five monitoring wells were required for closure of the landfill.

Photograph 2-1. Conditions at RQL, November 2003

RQL is currently managed as "Restricted Access" because the area includes environmentally sensitive areas (i.e., wetlands) and a closed landfill. Potential MEC has been observed along the eastern quarry wall slope. The landfill is currently under post-closure long-term monitoring and does not require remedial action. RQL 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 at RQL only after personnel have been properly briefed on potential hazards/sensitive areas. Authorized personnel must escort individuals that are unfamiliar with the hazards/restrictions at all times while in the restricted area (USACE 2005b).

2.2.2 Surface Features

Ground surface elevations across RQL range from approximately 291-302 m (955-990 ft) above mean sea level (AMSL) with the land sloping generally toward the quarry pond (Figure 2-3). The pond averages 2.3 acres in area, is typically less than 4 ft deep, and is often dry. Structural features include the quarry, the landfill, several drainage ditches, access roads, and a rail line. The quarry is unlined, approximately 10 acres in size, and 30-40 ft deep. The landfill has been closed and capped, and covers approximately 4 acres. The drainage ways and ditch lines, located along access roads and the rail line, only contain water during rain events. There is no surface water drainage from the quarry pond. Former quarry operations resulted in the removal of the original soil, leaving an area characterized by exposed bedrock on the ground surface and thin surface soils.

2.2.3 Previous Investigations

Three investigations have been conducted at RQL:

1. Initial Phase Groundwater Investigation Report (USACE 1999);
2. Final Phase Groundwater Investigation Report (USACE 2000); and
3. Phase I RI at RQL (USACE 2005b).

The Groundwater Investigation initial phase, conducted in July 1998, involved: (1) the installation and sampling of six new monitoring wells; (2) sampling of the existing RQL post-closure monitoring well system; (3) sampling of sediment and surface water within the quarry; and (4) construction of a staff gauge within the main quarry pond.

The follow-on phase of the Groundwater Investigation, which extended until July 15, 1999, included: (1) quarterly, dry season and wet season (storm event) sampling of the new monitoring well network and quarry pond surface water; (2) collection of long-term water levels from the new monitoring well network and quarry pond; (3) monthly manual water level measurements from all wells and the pond staff gauge; and (4) collection of precipitation data.

RQL remained relatively undisturbed between the Groundwater Investigation and Phase I RI. The Phase I RI at RQL was designed to collect data to supplement information obtained from the two-phased previous investigation. Phase I field activities were limited to groundwater and surface soil (0-1 ft below ground surface [BGS]).

2.2.4 Nature and Extent

Nature and extent of contamination of surface soils (0-1 ft BGS) and groundwater were determined in the Phase I RI at RQL. Figure 2-4 shows sampling locations and groundwater monitoring wells at RQL.

2.2.4.1 <u>Surface Soil Discrete Samples</u>

Explosives and propellants were detected at four discrete surface soil sample sites (0-1 ft BGS). Fourteen inorganic analytes were identified as site-related contaminants (SRCs), including: antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, silver, thallium, and zinc. The northwest area of the quarry had the sample location with the highest number of metals exceeding background concentrations (16). The sample locations with the lowest number of metals exceeding background concentrations were in the northern area of the AOC and in the southern area of the AOC. There were 20 semivolatile organic compounds (SVOCs) detected and SVOCs were detected at all sample locations. The maximum detected concentrations (MDCs) for nearly all SVOCs were observed in the northwest corner of the area. No volatile organic compounds (VOCs), pesticides, or polychlorinated biphenyls (PCBs) were detected.

2.2.4.2 Surface Soil Multi-increment Samples

The bottom of RQL, exclusive of the pond and landfill toe slope, was divided into approximately five equal areas. Inorganic constituents were detected at all sample locations. The number of constituents that exceeded background concentrations ranged from 8 to 12, with antimony, cadmium, chromium, copper, cyanide, lead, mercury, nickel, silver, and zinc all frequently observed above background. SVOCs were detected at all sample locations except one. The number of SVOCs detected ranged from 11 to 15. The maximum concentrations for nearly all analytes were observed in the northern area of the AOC. No explosives or propellants were detected.

2.2.4.3 Groundwater

Over three sampling events conducted during the Phase I RI, detected concentrations of metals above background occurred throughout Phase I RI groundwater wells at RQL; however, only three metals (arsenic, lead and manganese) were found to exceed USEPA Region 9 preliminary remediation goals (PRGs). The MDC of arsenic and lead were well below Ohio maximum contaminant levels (MCLs) and federal treatment standards. Low, estimated concentrations of a few VOCs (acetone, methylene chloride, carbon disulfide) and SVOCs (phthalate) were sporadically detected during the Phase I RI. Explosives, pesticides, and PCBs were not detected in any RQL groundwater monitoring well samples during the Phase I RI. The lack of explosives in Phase I RI wells indicates a limited extent of contaminant migration downgradient of the AOC.

2.2.5 Fate and Transport Analysis

Contaminant fate and transport modeling performed as part of the Phase I RI included leachate modeling [Seasonal Soil Compartment Model (SESOIL)]. Groundwater modeling [Analytical Transient 1-, 2-, 3-Dimensional (AT123D)] also was conducted from the source to selected receptors or exit points from the AOC. The receptor selected for groundwater transport modeling was the nearest perennial stream at its closest point downgradient of the AOC (unnamed tributary approximately 1,200 ft north of RQL).

2.2.5.1 SESOIL Modeling

1,3-Dinitrobenzene (DNB); 2,6-dinitrotoluene (DNT); nitroglycerin; hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); antimony; arsenic; chromium; and carbazole were identified as contaminant migration contaminants of potential concern (CMCOPCs) for RQL based on source loading predicted by the SESOIL modeling. In addition, manganese was detected in Phase I RI groundwater samples above its risk-based concentration (RBC) beneath the quarry, and it was identified as a CMCOPC.

2.2.5.2 AT123D Modeling

Nitroglycerin, RDX, and carbazole were identified as contaminant migration chemicals of concern (CMCOCs) based on AT123D modeling. Numerical modeling predicted that the maximum groundwater concentrations of these constituents could exceed MCLs or RBCs at the unnamed tributary at the closest point downgradient of the source areas. However, a refined assessment of contaminant fate and transport demonstrated that, based on modeled time frames to attain peak leaching concentrations and on actual observed groundwater concentrations, none of the constituents identified as CMCOCs are predicted to reach downgradient receptor locations. Either the predicted peak leaching concentration has already occurred (e.g., 2 years for RDX) or actual groundwater concentrations are less than modeling results. These data indicate a higher degree of attenuation than that accounted for by the numerical model, which assumed a constant source of contamination and no degradation of contaminants. A full discussion of contaminant fate and transport is presented in Section 3.5 and Appendix 3A.

2.2.6 Human Health Risk Assessment

The HHRA at RQL was conducted to evaluate risks and hazards associated with contaminated media at RQL for one representative receptor (Security Guard/Maintenance Worker) exposed to one medium and one exposure unit (shallow surface soil [0-1 ft BGS]). Direct contact (i.e., ingestion, dermal contact, and inhalation) exposure pathways were evaluated. In addition to the representative receptor (Security Guard/Maintenance Worker), the other four receptors described in the FWHHRAM (USACE 2004) [National Guard Dust/Fire Control Worker, National Guard Trainee, Hunter/Fisher, and Resident Subsistence Farmer (adult and child)] were evaluated for exposure to surface soil, groundwater, sediment, and surface water. These additional receptors are not anticipated at RQL due to physical constraints (e.g., wetlands, MEC, and landfill) and intended future land use by the OHARNG. The Resident Subsistence Farmer provides a baseline for evaluating this AOC with respect to residential release.

One metal (arsenic), seven polycyclic aromatic hydrocarbons (PAHs) [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene], and one SVOC (carbazole) were identified as COCs in shallow surface soil (0-1 ft BGS) for the representative receptor (i.e., Security Guard/Maintenance Worker) at RQL. The MDCs for all eight organic COCs were detected at station RQL-026.

An additional two deep surface soil (0-3 ft BGS) COCs were identified for the National Guard Trainee (chromium) and Resident Subsistence Farmer (2,6-DNT) exposure scenarios.

The Security Guard/Maintenance Worker is not exposed to groundwater, sediment, or surface water. COCs identified for these media for the other receptors evaluated are listed below:

- Two COCs (arsenic and manganese) were identified in groundwater.
- Four COCs [arsenic, chromium, manganese, and benzo(a)pyrene] were identified in sediment.
- Three COCs (arsenic, manganese, and aldrin) were identified in surface water.

A summary of the HHRA results is provided in Table 2-1.

Table 2-1. Summary of HHRA Risk Results for Direct Contact at the Ramsdell Quarry Landfill

Receptor	Total HI	Total ILCR	COCs	Notes
Security Guard/Maintenance Worker (Representative Receptor)				
Surface Soil	0.23	2.1E-03	As, Pb, carbazole, PAHs[a]	Exceeds USEPA and Ohio EPA target risk. Risks are driven by one sample (RQL-026) the next largest concentration is 1 to 2 orders of magnitude lower.
Fire/Dust Suppression Worker				
Surface Soil	0.0074	6.1E-05	PAHs[b]	Exceeds USEPA and Ohio EPA target risk. Risks are driven by one sample (RQL-026) the next largest concentration is 1 to 2 orders of magnitude lower.
Sediment	0.0060	5.5E-07	None	Below USEPA and Ohio EPA target risk values.
Surface Water	0.055	1.1E-06	None	Exceeds USEPA *de minimis* risk but below Ohio EPA target risk.
National Guard Trainee				
Surface Soil	0.53	3.0E-04	As, Cr, carbazole, PAHs[a]	Exceeds USEPA and Ohio EPA target risk. Risks are driven by one sample (RQL-026) the next largest concentration is 1 to 2 orders of magnitude lower.
Sediment	6.9	3.0E-05	As, Cr, Mn	Exceeds USEPA and Ohio EPA target risk.
Surface Water	0.66	8.8E-06	As, Aldrin	Exceeds USEPA *de minimis* risk but below Ohio EPA target risk.
Groundwater	0.51	1.1E-05	As	Exceeds USEPA and Ohio EPA target risk.
Resident Subsistence Farmer (Adult)				
Surface Soil	0.54	4.6E-03	As, Pb, 2,6-DNT, carbazole, PAHs[a]	Exceeds USEPA and Ohio EPA target risk. Risks are driven by one sample (RQL-026) the next largest concentration is 1 to 2 orders of magnitude lower.
Sediment	0.51	5.4E-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.
Surface Water	1.3	3.3E-05	As, Aldrin	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from aldrin is below Ohio EPA target risk.
Groundwater	4.6	1.2E-04	As, Mn	Exceeds USEPA and Ohio EPA target risk.
Resident Subsistence Farmer (Child)				
Surface Soil	2.4	2.8E-03	As, Pb, 2,6-DNT, carbazole, PAHs[a]	Exceeds USEPA and Ohio EPA target risk. Risks are driven by one sample (RQL-026) the next largest concentration is 1 to 2 orders of magnitude lower.
Sediment	3.0	6.1E-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.
Surface Water	3.4	2.3E-05	As, Mn, Aldrin	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from aldrin is below Ohio EPA target risk.
Groundwater	16	8.4E-05	As, Mn	Exceeds USEPA and Ohio EPA target risk.
Hunter/Trapper				
Surface Soil	0.0015	1.5E-05	PAHs[b]	Exceeds USEPA and Ohio EPA target risk. Risks are driven by one sample (RQL-026) the next largest concentration is 1 to 2 orders of magnitude lower.
Sediment	0.0011	1.4E-07	None	Below USEPA and Ohio EPA target risk values.
Surface Water	0.014	2.2E-07	None	

As = arsenic
B(*a*)P = benzo(*a*)pyrene
COC = Constituent of concern.
Cr = chromium (evaluated as hexavalent chromium)
2,6-DNT = 2,6-dinitrotoluene
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
Mn = manganese
Pb = lead
USEPA = U. S. Environmental Protection Agency.
Ohio EPA = Ohio Environmental Protection Agency.
RQL = Ramdell Quarry Landfill.
[a]PAH COCs for Security Guard/Maintenance Worker, National Guard Trainee, and Resident Subsistence Farmer = Benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, benzo(*k*)fluoranthene, chrysene, dibenz(*a*,*h*)anthracene, indeno(1,2,3-*cd*)pyrene.
[b]PAH COCs for Fire/Dust Suppression Worker and Hunter/Fisher = Benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a*,*h*)anthracene, and indeno(1,2,3-*cd*)pyrene (Fire/Dust Suppression Worker only).

2.2.7 Ecological Risk Assessment

RQL contains sufficient terrestrial and aquatic (soil, sediment, and surface water) habitat to support various classes of ecological receptors. The presence of suitable habitat and observed receptors at the AOC warrants a screening ecological risk assessment (SERA). Ohio EPA protocol (Level I) was met and Level II was needed. The US Army's RVAAP Facility-Wide Ecological Risk Assessment (ERA) Work Plan (USACE 2003a) was used to guide the work.

A Level II SERA was conducted at RQL. 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) MDCs are compared to ecological screening values (ESVs) as opposed to exposure point concentrations (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 RQL. Chemicals with no ESV are also retained as chemicals of potential ecological concern (COPECs). As part of this screen, all chemicals 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).

A SERA (Level II Screen) was conducted at RQL and identified multiple COPECs in surface soil (0-1 ft BGS) (USACE 2005b). A summary can be seen in Table 2-2. For the Level II Screen, Ohio EPA does not require that hazard quotients (HQs) be calculated when comparing the MDCs against the ESVs, so HQs were not calculated for the RQL. Soil COPECs have the potential to pose a hazard to plants and animals.

For surface soil (0-1 ft BGS) at RQL, there were a total of 45 COPECs identified with 35 of those being better substantiated. Twelve COPECs [9 inorganics, 2 explosives (1,3- DNB and 2,6-DNT), and 1 SVOC (2-methylnaphthalene)] were based solely on their MDC exceeding the ESV (Table 2-2). The inorganics included aluminum, antimony, arsenic, chromium, copper, nickel, iron, selenium, and vanadium. In addition, there were three COPECs, all SVOCs, based solely on being PBT compounds [acenaphthylene, anthracene, and bis(2-ethylhexyl)phthalate]. Furthermore, 4 inorganics (cadmium, lead, mercury, and zinc) and 14 SVOCs were COPECs based on two criteria that included having maximum detect concentrations exceeding the ESV and being PBT compounds. Ten chemicals were COPECs based solely on having no ESV, including 4 inorganics and 6 explosives. In addition, 2 SVOCs (carbazole and dibenzofuran) were COPECs based on two criteria because they had no ESV and they were PBT compounds. Thus, 35 surface soil (0-1 ft BGS) COPECs were identified based on either having an MDC exceeding the ESV and/or being PBT compounds (12 + 3 + 18 + 2), indicating that surface soil chemicals pose a potential for adverse effects to ecological receptors at the RQL.

In summary, the surface soil (0-1 ft BGS) has multiple COPECs (i.e., 35) that exceed the ESV and/or are PBT compounds. Organics comprised the majority of these COPECs (22 versus 13 inorganics). Although some of these COPECs likely overestimate the risk to ecological receptors due to low bioavailability of the chemicals for biological uptake from soil (e.g., aluminum) or low confidence in the ESVs (e.g., iron for plants), the presence of multiple COPECs indicates the potential for adverse effects to ecological receptors from these chemicals in the RQL surface soil (0-1 ft BGS).

Table 2-2. COPECs in Surface Soil (0-1 ft BGS) at RQL – SERA (Level II)

COPECs with MDC Greater Than ESV		
Aluminum Antimony Arsenic Chromium Copper	Iron Nickel Selenium Vanadium	1,3-Dinitrobenzene 2,6-Dinitrotoluene 2-Methylnaphthalene
COPECs with MDC Greater Than ESV and are PBTs		
Cadmium Lead Mercury Zinc	Acenaphthene Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(g,h,i)perylene Benzo(k)fluoranthene Chrysene	Dibenzo(a,h)anthracene Fluoranthene Fluorene Indeno(1,2,3-cd)pyrene Naphthalene Phenanthrene Pyrene
COPECs with MDC Less Than ESV but are Retained as PBTs		
Acenaphthylene	Anthracene	Bis(2-ethylhexyl)phthalate
COPECs Having No ESV and are PBTs		
Carbazole	Ddibenzofuran	
COPECs Having No ESV		
Calcium Magnesium Potassium Sodium	2-amino-4,6-DNT 4-amino-2,6-DNT HMX	Nitroglycerin 2-nitrotoluene RDX

BGS = Below ground surface.
COPECs = Contaminants of potential ecological concern.
ESV = Ecological screening value.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
MDC = Maximum detected concentration.
PBT = Persistent, bioaccumulative, and toxic compound (inorganics include cadmium, lead, mercury, and zinc; organics include Log K_{ow} of at least 3.0).
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

The SERA (Level II screen) also identified COPECs in sediment and surface water for the RQL location (USACE 2005b). The following 29 COPECs including 12 inorganics, 4 explosives, 12 SVOCs, and 1 VOC were identified in sediment:

Arsenic	Lead	2,4-Dinitrotoluene	Benzo(k)fluoranthene
Cadmium	Magnesium	HMX	Carbazole
Calcium	Manganese	Nitrocellulose	Chrysene
Copper	Mercury	3-Nitrotoluene	Fluoranthene
Cyanide	Nickel	Anthracene	Indeno(1,2,3-cd)pyrene
Iron	Zinc	Benzo(a)anthracene	Phenanthrene
		Benzo(a)pyrene	Pyrene
		Benzo(b)fluoranthene	Acetone
		Benzo(g,h,i)perylene	

Of the 29 retained sediment COPECs, 16 had maximum detectable concentrations that exceeded their ESV (7 inorganics, 1 explosive, 7 SVOCs, and 1 VOC), 8 had no ESVs (4 inorganics, 3 explosives, and 1 SVOC), and 5 were COPECs solely due to being PBT compounds (mercury and 4 SVOCs). Ten of the retained COPECs (cadmium, lead, zinc, and 7 SVOCs) had MDCs that exceeded the ESV and were also PBT compounds.

The following 17 COPECs including 15 inorganics, 1 pesticide, and 1 VOC were identified in surface water:

Aluminum	Cobalt	Mercury	Aldrin
Cadmium	Iron	Nitrate/Nitrite	Acetone
Calcium	Lead	Potassium	
Chloride	Magnesium	Sulfate	
Copper	Manganese	Zinc	

Of the 17 retained surface water COPECs, 4 had maximum detectable concentrations that exceeded the OAC Water Quality Criteria (WQC), 11 had no OAC WQC (9 inorganics, 1 pesticide, and 1 VOC), and 2 were COPECs solely due to being PBT compounds (cadmium and mercury). Three of the retained COPECs (lead, zinc, and aldrin) had maximum detectable concentrations that exceeded the ESV and were also PBT compounds.

In summary, sediment (29) and surface water (17) had multiple COPECs. Most sediment COPECs (17) were organics and almost all (15) surface water COPECs were inorganics. Some COPECs likely overestimate risks to benthos and aquatic life due to low bioavailability (aluminum and iron), antagonistic effects (PAHs), and other factors. Regardless, there are enough COPECs to suggest that some adverse effects could be associated with the chemical concentrations to ecological receptors.

2.3 RISK CHARACTERIZATION FOR TRESPASSER SCENARIO

The baseline HHRA provided in the RQL Phase I RI Report evaluates the potential health risks to humans resulting from exposure to contamination at RQL. The HHRA presented in the RQL Phase I 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 FS per the FWHHRAM Amendment #1 (USACE 2005c) to supplement 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 2 and is incorporated in subsequent sections of this FS, as appropriate.

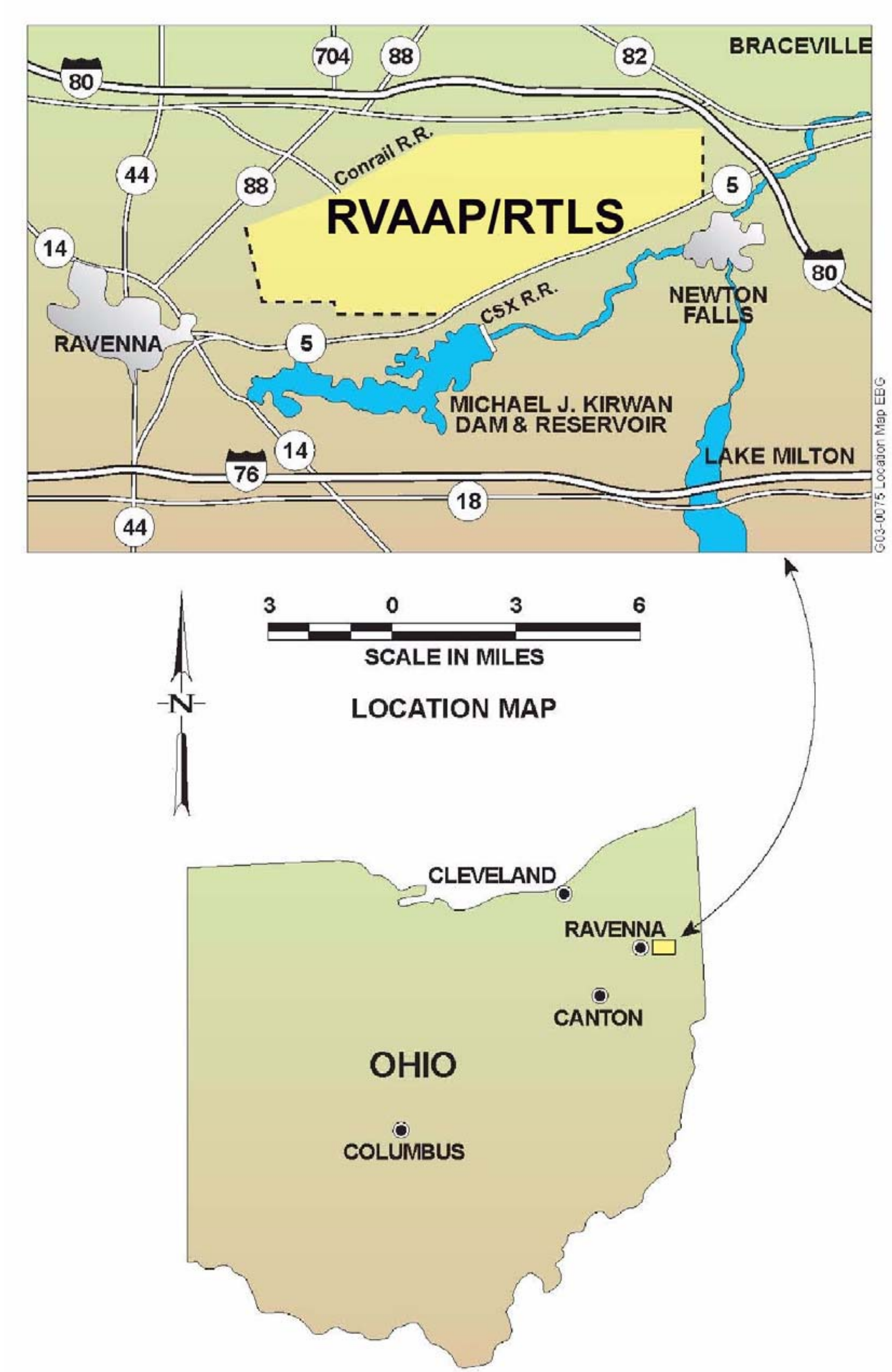

Figure 2-1. **General Location and Orientation of RVAAP/RTLS**

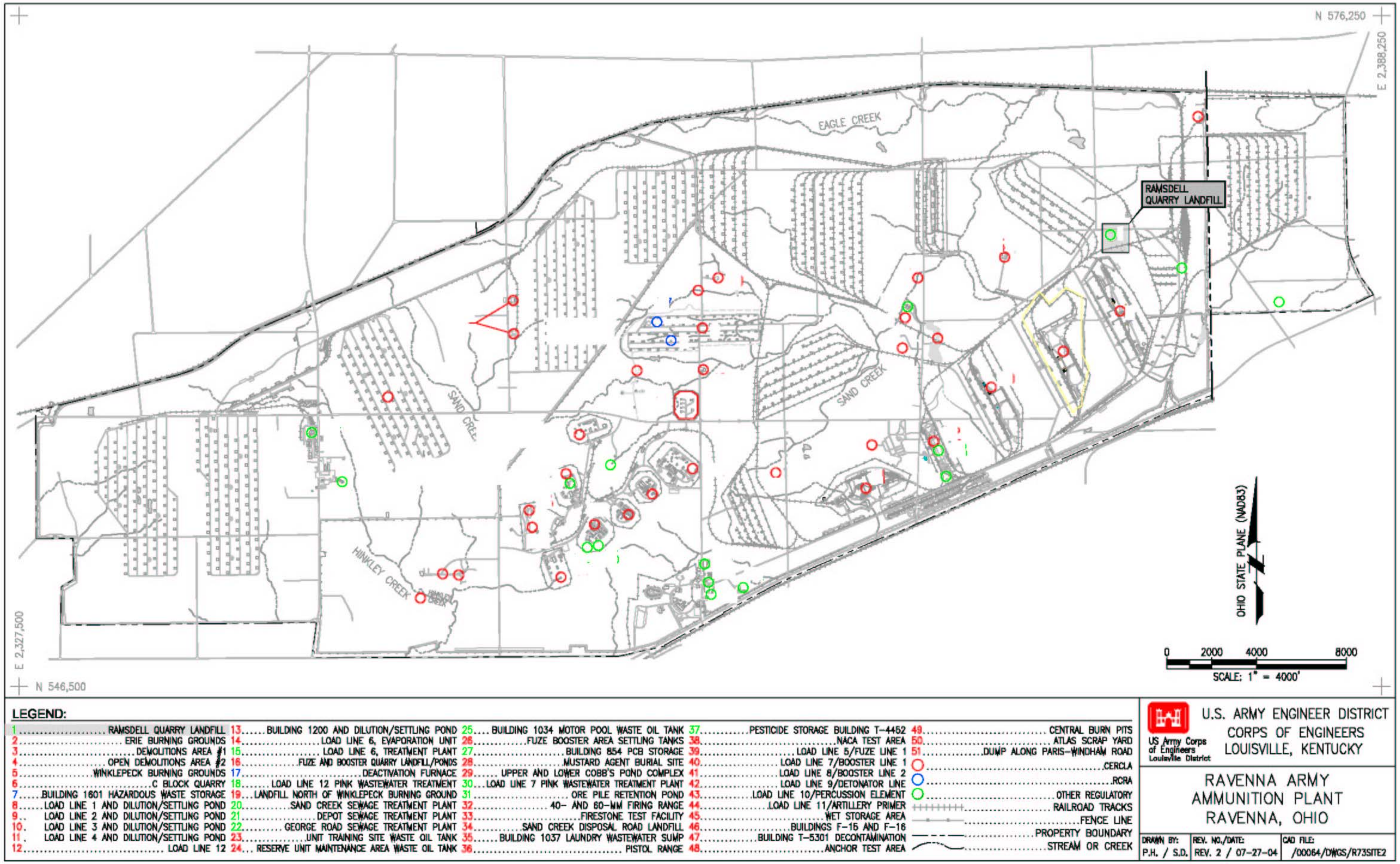

Figure 2-2. **RVAAP/RTLS Installation Map**

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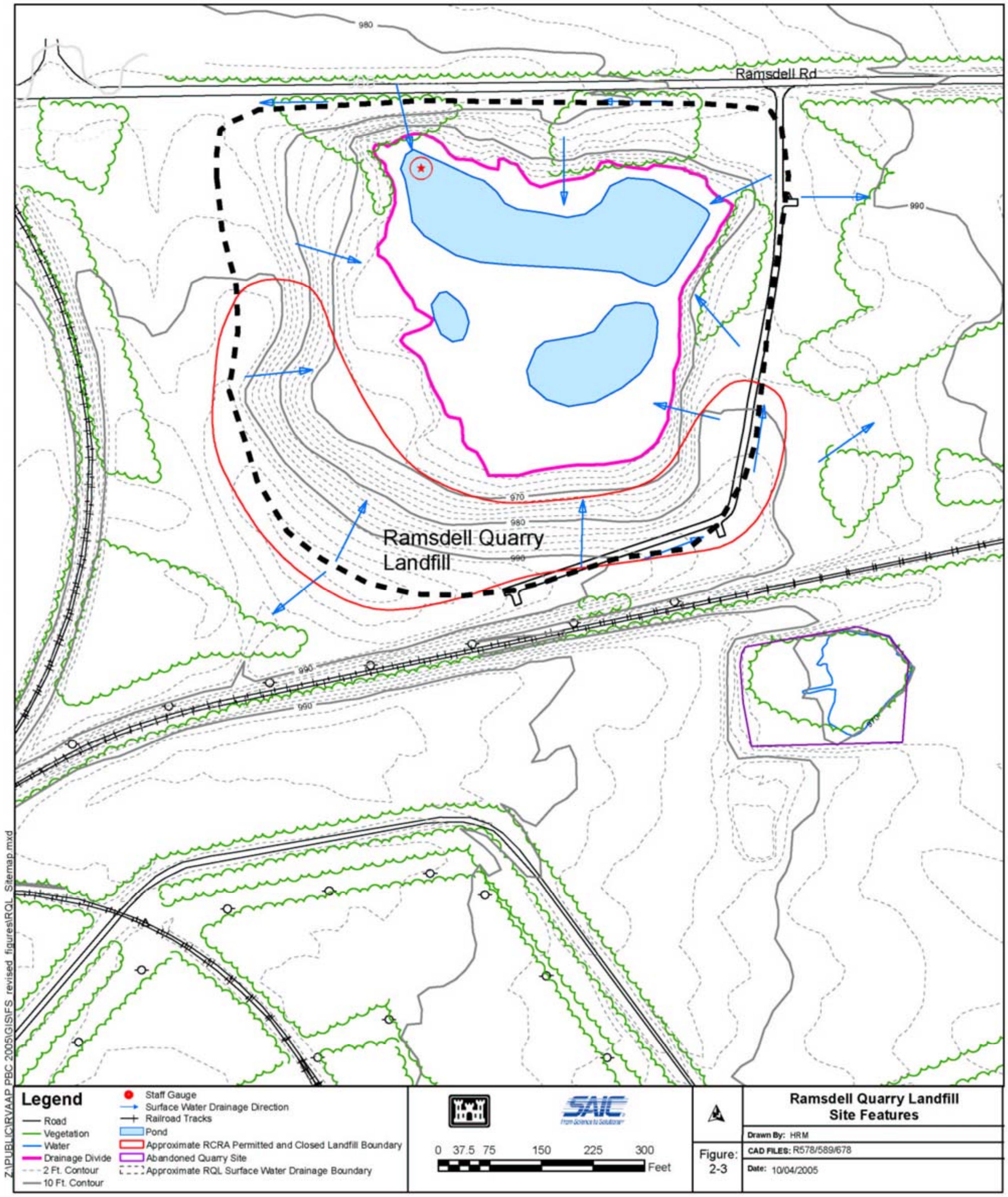

Figure 2-3. Features of RQL

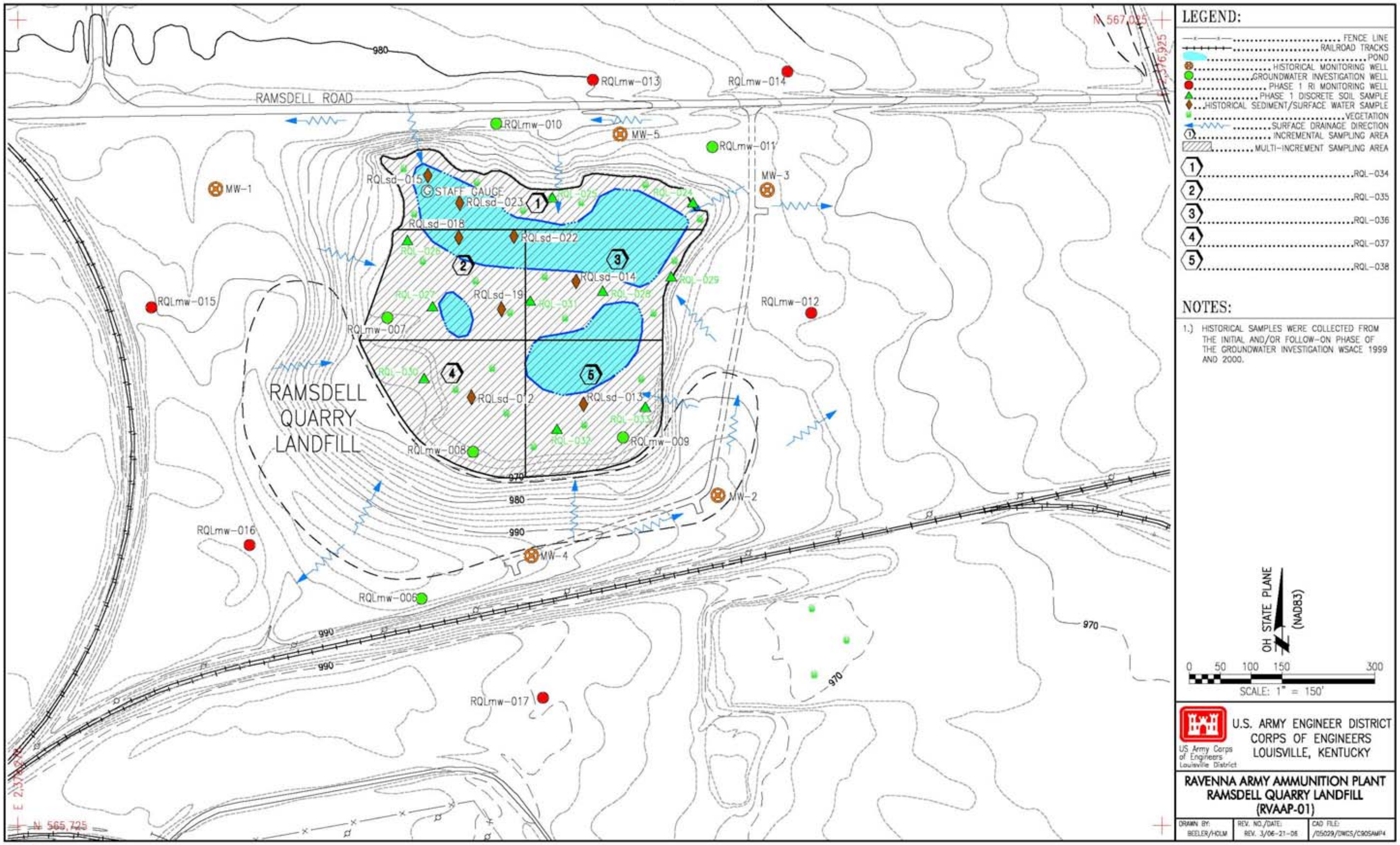

Figure 2-4. Sample and Monitoring Well Locations at RQL

3.0 REMEDIAL ACTION OBJECTIVES

This chapter of the FS describes the RAO developed for RQL. RAOs specify the requirements that remedial alternatives must fulfill to protect human health and the environment from contaminants and provide the basis for identifying and evaluating remedial alternatives in Sections 5, 6, and 7. The primary objectives of this chapter are:

1. To present the RAO for RQL;
2. To identify media-specific preliminary cleanup goals to meet this RAO;
3. To identify areas of soil, sediment, surface water, and groundwater where remediation may be needed to meet this RAO; and
4. To identify the extent of contamination to be used in volume calculations for evaluating removal/treatment alternatives.

The discussion in this chapter is organized as follows:

- RAO is presented in Section 3.1.
- Anticipated future land use is discussed in Section 3.2.
- Human health preliminary cleanup goals and the identification of COCs requiring further evaluation in this FS for remedial alternatives to meet this RAO are presented in Section 3.3.
- Ecological weight-of-evidence for meeting the RAO is presented in Section 3.4.
- An assessment of the potential for impacted soils to affect groundwater at the AOC and at an exposure point downgradient of the AOC is summarized in Section 3.5.
- A summary of the COCs and corresponding preliminary cleanup goals established for each medium at RQL based on the information presented in Sections 3.1 through 3.4 is presented in Section 3.6.
- The extent and volume of impacted soils/dry sediments to be addressed by the remedial alternatives evaluated in this FS are summarized in Section 3.7.

3.1 REMEDIAL ACTION OBJECTIVES

RAOs specify the requirements remedial alternatives must fulfill to protect human health and the environment from SRCs at RQL. Media-specific objectives that identify major contaminants and associated media-specific cleanup goals are developed to provide this protection. These objectives specify COCs, exposure routes and receptors, and acceptable constituent concentrations for long-term protection of receptors. The baseline risk assessment (BRA) conducted for RQL is summarized in Chapter 2 of this FS and detailed in Sections 6 and 7 of the Phase I RI Report for RQL (USACE 2005b).

As discussed in Chapter 2, the HHRA includes baseline risk calculations for a number of receptors for representative and residential land use scenarios. Table 3-1 lists the representative receptor and the residential receptor for each land use scenario at RQL.

Table 3-1. Land Use Scenarios Assessed in the RQL FS

Area of Concern	Land Use Scenario	Receptor
RQL	Restricted	Security Guard/Maintenance Worker
	Residential	Resident Subsistence Farmer

Land use at RQL may change in time, but the receptors shown in Table 3-1 are the receptors assessed for the purposes of this FS. The representative receptors correspond to active (National Guard Trainee) and restricted (Security Guard/Maintenance Worker, Fire/Dust Suppression Worker) National Guard land uses. The Resident Subsistence Farmer provides a baseline for evaluating whether RQL may be eligible for unrestricted release; however, RQL is not currently a candidate for unrestricted release because of the presence of MEC, which will be investigated in the MMRP. Other receptors, in addition to the representative receptor and Resident Subsistence Farmer, are evaluated in the baseline HHRA for RQL. The representative receptors selected at RQL are protective of other activities that may occur under anticipated future land use. In addition to the receptors evaluated in the HHRA, an Adult and Juvenile Trespasser is evaluated in this FS (Appendix 2).

Cleanup goals are based on the evaluation of both the representative and residential scenarios. More information can be found in Section 3.3 regarding representative receptors, risk calculations, and preliminary cleanup goals.

The ecological risk assessment performed for RQL identifies a variety of ecological receptor populations that could be at risk and identifies the COPECs and chemicals of ecological concern (COECs) that could contribute to potential risks from exposure to contaminated media. Ohio EPA guidance (Ohio EPA 2003) allows a decision about remediation to be made at the completion of each level of risk assessment. A decision whether it is necessary to remediate because of potential harm to ecological receptors at RQL is not included in the RI Report. Section 3.4 provides weight-of-evidence input for that decision. When a human health cleanup goal is chosen, it offers dual protectiveness to human health and ecological resources after any habitat disturbance has been reversed through ecological succession or environmental management.

All necessary CERCLA remediation requirements with respect to soils and dry sediments will be performed to achieve remedy at RQL. Remediation with respect to groundwater, surface water, and wet sediments are not included in the scope of this FS. However, remedy with respect to soils and dry sediments must be protective of groundwater. The following RAO is developed accordingly for impacted soils and dry sediments at RQL:

- Prevent Security Guard/Maintenance Worker exposure to contaminants in soils and dry sediments which exceed risk-based cleanup goals to a depth of 1 ft BGS.

Due to the presence of bedrock, the remedial investigation at RQL was limited to surface soil samples (0-1 ft). At RQL, preliminary cleanup goals are developed for impacted environmental media including groundwater, surface water, and wet sediments (in addition to soils and dry sediments) to facilitate future considerations with respect to selection of remedies for these media.

3.2 ANTICIPATED FUTURE LAND USE

OHARNG has prepared a comprehensive Environmental Assessment and an Integrated Natural Resources Management Plan to address future use of RTLS property (OHARNG 2001). OHARNG has established future land use for RQL as Restricted Access, No Digging based on anticipated training mission and utilization of the RTLS (USACE 2004). Future land use is discussed in more detail in Section 3.3

3.3 IDENTIFICATION OF HUMAN HEALTH PRELIMINARY CLEANUP GOALS FOR RQL

This section documents the proposed land use and corresponding preliminary cleanup goals to support the remedial alternative selection process for soil remediation at RQL. Preliminary cleanup goals are the chemical-specific numeric cleanup goals used to meet the remedial action objective for protection of human health.

The HHRA performed for RQL is detailed in the RI Report and summarized in Chapter 2 of this FS. The HHRA included in the 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/Fisher, and Resident Subsistence Farmer (adult and child)] that could be at risk, and identifies the COCs that could contribute to potential risks from exposure to contaminated media within the AOC. In addition to the receptors in the HHRA, a Trespasser (Adult and Juvenile) is evaluated in this FS (Appendix 2). The HHRA also documents the calculation of risk-based remedial goal options (RGOs) for human receptors for all media (i.e., soil, surface water, sediment, 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 FS.

Chemical-specific preliminary cleanup goals are established for restricted and residential land use from these risk-based cleanup goals, background concentrations, and other information in this section. Preliminary cleanup goals for restricted land use are established for a representative receptor (Security Guard/Maintenance Worker) for likely future land use by the OHARNG. The preliminary cleanup goals for the Security Guard/Maintenance Worker are protective of other potential receptors with equal or lesser exposure assumptions than the representative receptor and; therefore, serve as surrogates for these other possible receptors (e.g., preliminary cleanup goals for the Security Guard/Maintenance Worker are also protective of a hunter). The potential for the Security Guard/Maintenance Worker to be protective of a trespasser to the AOC is also addressed. In addition to the Security Guard/Maintenance Worker, preliminary cleanup goals are established for a Resident Subsistence Farmer (adult and child) to provide a baseline for evaluating whether this AOC 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 (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 for RDX. Equations, exposure parameters, and toxicity values [cancer slope factors (CSF) and non-cancer reference doses] 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 RQL 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 Appendix 3A.

The risk-based cleanup goals assumed combined exposure through ingestion, inhalation of vapors and fugitive dust, and dermal contact with contaminated media. For chemicals 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, then the background concentration is selected as the preliminary cleanup goal.

The list of human health COCs for evaluation of remedial alternatives in this FS are identified for RQL based on risk management considerations including:

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

- Comparison of EPC to upgradient concentrations for sediment, surface water, and groundwater;

- Consideration of soil 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 RQL (Section 3.3.1);

- A summary of COCs identified in the HHRA (Section 3.3.2);

- 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 3.3.3);

- Chemical-specific preliminary cleanup goals (Section 3.3.4); and

- Risk management considerations and the identification of COCs to be carried through the evaluation of remedial alternatives in this FS (Section 3.3.5).

3.3.1 Land Use and Potential Receptors at RQL

RQL includes environmentally sensitive areas (i.e., wetlands), a closed landfill, and may contain MEC and, as a result, is managed as "Restricted Access" and will remain Restricted Access in the future. RQL 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 at RQL only after authorized personnel have been properly briefed on potential hazards/sensitive areas. Authorized personnel must escort individuals that are unfamiliar with the hazards/restrictions at all times while in the restricted area (USACE 2005b). In addition to MEC concerns, the requirement to protect the landfill cap precludes changes in future land use.

Given the restricted access to RQL, the most likely receptors are individuals entering the area on an occasional basis to evaluate wildlife to meet the needs of natural resources management (e.g., wildlife biologist) or to check the status of the area for security or safety reasons, or maintenance workers performing periodic mowing, landfill cap repair, and periodic post-closure groundwater sampling. None of these activities involve routine exposure at RQL; rather, they are occasional activities. Also, none of these activities involve contact with wetlands when they are present (i.e., maintenance workers are not expected to work in areas that are under water).

RQL is considered a seasonal wetland and is not a fishery because of the fluctuating water level. Trespassers are possible, although unlikely at RVAAP; however, access to RQL is restricted due to MEC concerns and trespassers are not expected at this AOC. Hunting is not allowed within the AOC.

Based on this information, the Security Guard/Maintenance Worker scenario outlined in Table 5 of the FWHHRAM (USACE 2004) is protective of potential receptors at RQL. This scenario assumes a Security Guard/Maintenance Worker patrols RQL every day for 1 hr (i.e., 1 hr/day, 250 days/year for a total of 250 hr/year, for 25 years). Although a security guard is not currently exposed to contaminated media at RQL on a daily basis, the potential exposure of this receptor is considered protective of receptors with more irregular exposure (e.g., a wildlife ecologist who spends several days at the AOC once every few years, security personnel who may periodically evaluate the AOC, or workers engaged in periodic maintenance).

The Security Guard/Maintenance Worker is assumed to be exposed to shallow surface soil (0-1 ft BGS) only. This receptor is not involved in recreational or training activities that would result in exposure to surface water or sediment. Exposures to contaminants in shallow surface soil (0-1 ft BGS) at RQL are evaluated for a Security Guard/Maintenance Worker for soil ingestion, dermal contact with soil, and inhalation of soil particles and VOCs.

While the intended future land use for RQL does not include recreational use, if hunting restrictions are relaxed, then the preliminary cleanup goals established for the Security Guard/Maintenance Worker will be protective of a recreational receptor exposed to contaminants in soil during hunting, trapping, and fishing because these recreational activities are assumed to result in exposure 4.57 hr/day, 7 days/year (32 hr/year) for 30 years. The Security Guard/Maintenance Worker is also protective of a Juvenile Trespasser who is assumed to visit the AOC 2 hr/day, 50 days/year (100 hr/year) for 10 years and an Adult Trespasser who is assumed to visit the AOC 2 hr/day, 75 days/year (150 hr/year) for 30 years.

In addition to the representative receptor (Security Guard/Maintenance Worker) described above, the Resident Subsistence Farmer (adult and child) provides a baseline for evaluating whether this AOC may be eligible for unrestricted release; however, RQL is not currently a candidate for unrestricted release because of the suspected presence of munitions and explosives of concern which will be investigated in the MMRP. MEC concerns and the presence of a closed landfill will most likely preclude RQL from unrestricted 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.

3.3.2 Constituents of Concern Identified in the HHRA

COCs are identified in the HHRA as chemicals with an ILCR greater than 1E-06 and/or a hazard index (HI) greater than 1 for a given receptor. COCs were identified in the HHRA for each exposure medium and receptor evaluated. COCs identified in the HHRA for the Security Guard/Maintenance Worker and Resident Subsistence Farmer (adult and child) are summarized below.

3.3.2.1 <u>COCs in Soil and Sediment</u>

RQL is an ephemeral wetland that varies from season to season and year to year. At times, the entire wetland may have no standing water; therefore, all of the sediments at RQL are evaluated as soil in this FS. Although, historically large portions of the quarry bottom have been inundated and are not as great an exposure risk (i.e., no sediments are treated as permanent underwater sediment). Soil and sediment COCs identified in the HHRA for the Security Guard/Maintenance Worker and Resident Subsistence Farmer (adult and child) are summarized below.

No non-carcinogenic soil COCs were identified for the Security Guard/Maintenance Worker. Ten carcinogenic soil COCs were identified for this receptor including: two metals (arsenic and lead) and eight SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, carbazole, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

No non-carcinogenic soil COCs were identified for the Resident Subsistence Farmer. Eleven carcinogenic soil COCs were identified for this receptor including: two metals (arsenic and lead), one explosive (2,6-DNT), and eight SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, carbazole, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

One non-carcinogenic sediment COC (arsenic) was identified for the Resident Subsistence Farmer. Two carcinogenic sediment COCs were identified for this receptor including: one metal (arsenic) and one SVOC [benzo(a)pyrene].

A Trespasser (Juvenile and Adult) is evaluated in Appendix 2 to supplement the Security Guard/Maintenance Worker and Resident Subsistence Farmer land use. The SVOCs identified as soil COCs for the Security Guard/Maintenance Worker are also COCs for the Trespasser. Arsenic is identified as a COC for sediment for the Trespasser.

3.3.2.2 COCs in Surface Water

The Security Guard/Maintenance Worker is not exposed to surface water; therefore, no COCs were identified for this receptor.

Three surface water COCs (two metals: arsenic and manganese, and one pesticide: aldrin) were identified in the HHRA for the Resident Subsistence Farmer (adult and child).

Arsenic and aldrin (adult only) are also identified as COCs for the Trespasser (Appendix 2).

3.3.2.3 COCs in Groundwater

The Security Guard/Maintenance Worker is not exposed to groundwater; therefore, no COCs were identified for this receptor.

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

The Trespasser is not exposed to groundwater; therefore, no COCs were identified for this receptor.

3.3.3 Target Risk for Preliminary Cleanup Goals

The FWHHRAM (USACE 2004) identifies a 1E-05 target for cumulative ILCR (TR) for carcinogens and an acceptable target THI of 1 for non-carcinogens consistent with Ohio EPA guidance, with the caveat that exposure to multiple COCs may 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 RQL 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 the preliminary cleanup goals for soil and sediment at RQL based on the small number of COCs present and the types of COCs (carcinogenic or non-carcinogenic) as summarized below.

The Security Guard/Maintenance Worker is the representative receptor for RQL under a restricted (military mission) land use. Ten soil COCs were identified for this receptor. Nine COCs are carcinogenic (arsenic has both carcinogenic and non-carcinogenic effects, but its preliminary cleanup goal is dominated by the carcinogenic effects) and one COC is lead. Of these nine carcinogenic COCs, one (arsenic) potentially produces respiratory system tumors, two are associated with stomach tumors [benz(a)anthracene and benzo(a)pyrene], three are associated with general tumors [benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene], one is associated with liver tumors (carbazole), one with carcinomas and malignant lymphoma (chrysene), and one with immunodepressive effects [dibenz(a,h)anthracene]. One additional carcinogenic COC was identified for the Resident Subsistence Farmer. 2,6-DNT is associated with liver carcinoma, mammary adenomas, and fibromas. By comparison, only two sediment COCs were identified for the Resident Subsistence Farmer.

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 both soil and sediment at RQL.

The Security Guard/Maintenance Worker is not exposed to surface water or groundwater. Only three surface water COCs and two groundwater COCs were identified for the Resident Subsistence Farmer; 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 RQL.

3.3.4 Preliminary Cleanup Goals

3.3.4.1 Soil and Sediment Preliminary Cleanup Goals

Risk-based cleanup goals calculated in the HHRA for COCs in soil, background concentrations for inorganics, and preliminary cleanup goals are presented for the Security Guard/Maintenance Worker in Table 3-2.

Table 3-2. Soil Preliminary Cleanup Goals for Security Guard/Maintenance Worker Scenario at RQL[a]

COC	EPC (mg/kg)	Risk-Based Cleanup Goal from HHRA (mg/kg)		Background[b] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	15	420	26	15	26
Lead	733	--	--	26	750[c]
Semivolatiles					
Benz(a)anthracene	260	--	13	NA	13
Benzo(a)pyrene	180	--	1.3	NA	1.3
Benzo(b)fluoranthene	220	--	13	NA	13
Benzo(k)fluoranthene	110	--	130	NA	130
Carbazole	85	--	610	NA	610
Chrysene	190	--	1300	NA	1300
Dibenz(a,h)anthracene	33	--	1.3	NA	1.3
Indeno(1,2,3-cd)pyrene	116	--	13	NA	13

[a] Shallow (0-1 ft BGS) surface soil is used for Security Guard/Maintenance Worker.
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant (RVAAP) from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the RVAAP, Ravenna, Ohio (USACE 1999).
[c] No risk-based cleanup goals were calculated for lead. The U. S. Environmental Protection Agency Region 9 preliminary remediation goal (PRG) (http://www.epa.gov/region09/waste/ sfund/prg/index.html) is used.
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background concentrations are used for inorganic COCs only.
Risk-based cleanup goal = Remedial goal option (RGO) calculated in the Human Health Risk Assessment (HHRA).

Estimated EPCs for arsenic, lead, benzo(k)fluoranthene, carbazole, and chrysene are less than the preliminary cleanup goals established for these COCs for the Security Guard/Maintenance Worker Scenario.

Risk-based cleanup goals calculated in the HHRA for COCs in soil and sediment, background concentrations for inorganics, and preliminary cleanup goals for the Resident Subsistence Farmer are presented in Tables 3-3 and 3-4, respectively.

Table 3-3. Soil Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at RQL[a]

COC	EPC (mg/kg)	Risk-Based Cleanup Goal from HHRA (mg/kg)				Background[b] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
		Adult		Child			
		HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics							
Arsenic	15	130	6.7	22	5.7	15	15
Lead	733	--	--	--	--	26	400[c]
Explosives							
2,6-Dinitrotoluene	1.6	220	7.6	64	11	NA	7.6
Semivolatiles							
Benz(a)anthracene	260	--	5.9	--	9.7	NA	5.9
Benzo(a)pyrene	180	--	0.59	--	0.97	NA	0.59
Benzo(b)fluoranthene	220	--	5.9	--	9.7	NA	5.9
Benzo(k)fluoranthene	110	--	59	--	97	NA	59
Carbazole	85	--	260	--	370	NA	260
Chrysene	190	--	590	--	970	NA	590
Dibenz(a,h)anthracene	33	--	0.59	--	0.97	NA	0.59
Indeno(1,2,3-cd)pyrene	120	--	5.9	--	9.7	NA	5.9

[a] Shallow (0-1 ft BGS) surface soil is used for Resident Subsistence Farmer.
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant (RVAAP) from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the RVAAP, Ravenna, Ohio (USACE 1999).
[c] No risk-based cleanup goals were calculated for lead. U. S. Environmental Protection Agency has defined residential soil-lead hazards as 400 ppm for play areas (40 *CFR* 745, "Lead: Identification of Dangerous Levels of Lead: Final Rule").
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background concentrations are used for inorganic COCs only.
Risk-based cleanup goal = Remedial goal option (RGO) calculated in the Human Health Risk Assessment (HHRA).

Estimated EPCs for arsenic, 2,6-DNT, carbazole, and chrysene in soil are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario.

Table 3-4. Sediment Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at RQL

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	33	130	6.7	22	5.7	20	20
Semivolatiles							
Benzo(a)pyrene	0.34	--	0.59	--	0.97	NA	0.59

[a]Final facility-wide background values for the Ravenna Army Ammunition Plant (RVAAP) from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the RVAAP, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background concentrations are used for inorganic COCs only.
Risk-based cleanup goal = Remedial goal option (RGO) calculated in the Human Health Risk Assessment (HHRA).

The estimated EPC of benzo(a)pyrene in sediment is less than the preliminary cleanup goal for this COCs for the Resident Subsistence Farmer Scenario.

3.3.4.2 Surface Water 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 Resident Subsistence Farmer are presented in Table 3-5.

Table 3-5. Surface Water Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at RQL

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	0.022	0.17	0.0089	0.042	0.011	0.0032	0.0089
Manganese	5.6	6.0	--	2.6	--	0.39	2.6
Pesticides							
Aldrin	0.000012	0.00032	0.000015	0.00018	0.00004	NA	0.000015

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant (RVAAP) from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the RVAAP, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background concentrations are used for inorganic COCs only.
Risk-based cleanup goal = Remedial goal option (RGO) calculated in the Human Health Risk Assessment (HHRA).

The estimated EPC of aldrin in surface water is less than the preliminary cleanup goal for this COC for the Resident Subsistence Farmer Scenario.

3.3.4.3 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 3-6.

Table 3-6. Groundwater Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at RQL

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	0.0068	0.011	0.00057	0.0031	0.00081	0	0.00057
Manganese	6.2	1.6	--	0.46	--	1.3	1.3

[a] Final facility-wide background values for the Ravenna Army Ammunition Plant (RVAAP) from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 1999). A value of 0 is used for metals not detected.
-- = Toxic endpoint not evaluated for this COC.
COC = constituent of concern.
EPC = Exposure point concentration.
HI = hazard index.
ILCR = incremental lifetime cancer risk.
NA = Not applicable. Background concentrations are used for inorganic COCs only.
Risk-based cleanup goal = Remedial goal option (RGO) calculated in the Human Health Risk Assessment (HHRA).

3.3.5 Risk Management Considerations

3.3.5.1 Soil and Sediment

For the Security Guard/Maintenance Worker, five soil COCs [benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; dibenz(a,h)anthracene; and indeno(1,2,3-cd)pyrene] are recommended as COCs for evaluation of remedial alternatives in this FS for surface soil (0-1 ft BGS). As shown in Table 3-7, the EPCs for these five PAHs exceed the preliminary cleanup goals established for the Security Guard/Maintenance Worker Scenario. The high EPC for these five PAHs is due to concentrations that occur at one sample location (RQL-026). Only one other sample location (RQL-025) had concentrations of one of these five COCs above preliminary cleanup goals. No other surface soil COCs are recommended as COCs for evaluation of remedial alternatives in this FS for the Security Guard/Maintenance Worker for the following reasons:

- The EPC for arsenic (15 mg/kg) is similar to background (surface 15 mg/kg, subsurface 20 mg/kg) and less than the preliminary cleanup goal established for the Security Guard/Maintenance Worker scenario and only one detected concentration exceeds background and the preliminary cleanup goal (Table 3-7). Soils at RQL have been disturbed and bedrock is near the surface in the bottom of the quarry; therefore, it is appropriate to review EPCs in the context of both surface and subsurface soil background. Also, it is unlikely that a Security Guard/Maintenance Worker would be exposed to concentrations at this single location over the entire exposure period for this representative receptor (250 hr/year for 25 years).

- The EPC for lead is less than the preliminary cleanup goals established for this chemical for the Security Guard/Maintenance Worker scenario and only one detected concentration exceeds the preliminary cleanup goal (Table 3-7). Sample results in the vicinity of this one sample have concentrations below the preliminary cleanup goal. Also, as noted above, it is unlikely that a Security Guard/Maintenance Worker would be exposed to concentrations at this single location over the entire exposure period for this representative receptor.

- The EPC for benzo(k)fluoranthene is less than the preliminary cleanup goals established for this chemical for the Security Guard/Maintenance Worker scenario and only one detected concentration exceeds the preliminary cleanup goal (Table 3-7). Other samples in the vicinity of this one sample have concentrations below the preliminary cleanup goal. As noted above, it is unlikely that a Security Guard/Maintenance Worker would be exposed to concentrations at this single location over the entire exposure period for this representative receptor.

- The EPCs and all detected concentrations of carbazole and chrysene are less than the preliminary cleanup goals established for these chemicals for the Security Guard/Maintenance Worker scenario.

For Resident Subsistence Farmer land use, seven soil COCs [lead; benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(k)fluoranthene; dibenz(a,h)anthracene; and indeno(1,2,3-cd)pyrene] are recommended as COCs for evaluation of remedial alternatives in this FS. As shown in Table 3-8, the EPCs for these seven chemicals exceed the preliminary cleanup goals established for the Resident Subsistence Farmer land use. Other soil COCs identified in the HHRA are not recommended for evaluation of remedial alternatives in this FS for Resident Subsistence Farmer land use for the following reasons:

- The EPC for arsenic (15 mg/kg) is similar to background (surface 15 mg/kg, subsurface 20 mg/kg) and less than the preliminary cleanup goals established for the Resident Subsistence Farmer scenario and only one detected concentration within the RQL exposure unit exceeds background and the preliminary cleanup goal (Table 3-8). Soils at RQL have been disturbed and bedrock is near the surface in the bottom of the quarry; therefore, it is appropriate to review EPCs in the context of both surface and subsurface soil background. Also, it is unlikely that a resident would be exposed to concentrations at this individual location over the entire exposure period (e.g., 24 hr/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

- EPCs for 2,6-DNT, carbazole, and chrysene are less than the preliminary cleanup goals established for these chemicals for the Resident Subsistence Farmer scenario (Table 3-8). These three chemicals also only have one detected concentration within the RQL exposure unit that exceeds the preliminary cleanup goal. Surrounding samples have concentrations below the preliminary cleanup goals established for these chemicals. As noted above, it is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period.

No sediment COCs are identified for evaluation of remedial alternatives in this FS for Resident Subsistence Farmer land use for the following reasons:

- The sediment EPC (which is the MDC due to small sample size) for arsenic exceeds background; however, only two detected concentrations in sediment exceed background (Table 3-8). The MDC in sediment (33 mg/kg) is similar to the MDC in soil (30 mg/kg) in the bottom of the quarry. Actual exposure to these two media would be very similar since water levels vary widely.

- The EPC and all detected concentrations for benzo(a)pyrene are less than the preliminary cleanup goal established for this chemical for the Resident Subsistence Farmer scenario (Table 3-8).

3.3.5.2 <u>Surface Water</u>

No surface water COCs are identified for evaluation of remedial alternatives for the representative receptor because the Security Guard/Maintenance Worker is not exposed to surface water.

No surface water COCs are identified for evaluation of remedial alternatives for Resident Subsistence Farmer land use for the following reasons:

- As shown in Table 3-9, the EPCs for two metals (arsenic and manganese) exceed the preliminary cleanup goals established for the Resident Subsistence Farmer; however, these metals are not recommended as COCs because these metals are not present above background in the surrounding soil indicating no AOC-related source to the surface water.

- The estimated EPC and the only detected concentration of aldrin in surface water are less than the preliminary cleanup goal for this COC for the Resident Subsistence Farmer Scenario (Table 3-9).

3.3.5.3 <u>Groundwater</u>

No groundwater COCs are identified for evaluation of remedial alternatives for the representative receptor because the Security Guard/Maintenance Worker is not exposed to groundwater.

No groundwater COCs are identified for evaluation of remedial alternatives for Resident Subsistence Farmer land use because, while the EPCs for two metals (arsenic and manganese) exceed the preliminary cleanup goals established for the Resident Subsistence Farmer (Table 3-9), these metals are not present above background in the overlying soil (not inclusive of the landfill) indicating no AOC-related soil source to the groundwater.

Table 3-7. Soil COCs for Evaluation of Remedial Alternatives for Security Guard/Maintenance Worker Land Use at RQL

COC[a]	Freq. of Detect	Measured Concentration (mg/kg) Avg.	Max.[b]	EPC[c]	Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
Arsenic	15/15	13	30	15	15	1	26	1	EPC less than background/preliminary cleanup goal	NC
Lead	15/15	303	3710	733	26	12	750	1	EPC less than preliminary cleanup goal	NC
Benz(a)anthracene	12/15	94	1400	259	NA	NA	13	1	EPC exceeds preliminary cleanup goal	FSCOC
Benzo(a)pyrene	12/15	65	960	177	NA	NA	1.3	2	EPC exceeds preliminary cleanup goal	FSCOC
Benzo(b)fluoranthene	12/15	81	1200	222	NA	NA	13	1	EPC exceeds preliminary cleanup goal	FSCOC
Benzo(k)fluoranthene	11/15	39	580	107	NA	NA	130	1	EPC less than preliminary cleanup goal	NC
Carbazole	7/15	31	460	85	NA	NA	610	0	All detects less than preliminary cleanup goal	NC
Chrysene	12/15	68	1000	185	NA	NA	1300	0	All detects less than preliminary cleanup goal	NC
Dibenz(a,h)anthracene	3/15	12	180	33	NA	NA	1.3	1	EPC exceeds preliminary cleanup goal	FSCOC
Indeno(1,2,3-cd)pyrene	12/15	43	630	116	NA	NA	13	1	EPC exceeds preliminary cleanup goal	FSCOC

[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) 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 (RVAAP) from the Phase II RI Report for the Winklepeck Burning Grounds at the RVAAP, Ravenna, Ohio (USACE 1999).
[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. (Figure 2-4 displays soil locations.)
One surface soil sample (RQL-025) had arsenic detected (30 mg/kg) above its preliminary cleanup goal of 26 mg/kg.
One surface soil sample (RQL-026) had lead detected (3710 mg/kg) above its preliminary cleanup goal of 750 mg/kg.
One surface soil sample (RQL-026) had benz(a)anthracene detected (1400 mg/kg) above its preliminary cleanup goal of 13 mg/kg.Two surface soil samples had benzo(a)pyrene detected above its preliminary cleanup goal of 1.3 mg/kg: RQL-025 (6.8 mg/kg) and RQL-026 (960 mg/kg).
One surface soil sample (RQL-026) had benzo(b)fluoranthene detected (1200 mg/kg) above its preliminary cleanup goal of 13 mg/kg.
One surface soil sample (RQL-026) had benzo(k)fluoranthene detected (580 mg/kg) above its preliminary cleanup goal of 130 mg/kg.
One surface soil sample (RQL-026) had dibenz(a,h)anthracene detected (180 mg/kg) above its preliminary cleanup goal of 1.3 mg/kg.
One surface soil sample (RQL-026) had indeno(1,2,3-cd)pyrene detected (630 mg/kg) above its preliminary cleanup goal of 13 mg/kg.
[f]Preliminary cleanup goal from Table 3-2.
[g]Recommendation for COCs for evaluation of remedial alternatives.
Detects = Detectable concentrations.
FSCOC = COC for evaluation of remedial alternatives.
NA = Not applicable. Background criteria are used only for naturally occurring inorganic constituents.
NC = Not recommended as a COC for remedial alternative evaluation.

Table 3-8. Soil and Sediment COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at RQL

COC[a]	Freq. of Detect	Measured Concentration (mg/kg) Avg.	Max.[b]	EPC[c]	Bkg[d] (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
Soil										
Arsenic	15/15	13	30	15	15	1	15	1	EPC less than background/preliminary cleanup goal	NC
Lead	15/15	303	3710	733	26	12	400	1		FSCOC
2,6-Dinitrotoluene	1/15	0.62	8.2	1.6	NA	NA	7.6	1	EPC less than preliminary cleanup goal	NC
Benz(a)anthracene	12/15	94	1400	259	NA	NA	5.9	2		FSCOC
Benzo(a)pyrene	12/15	65	960	177	NA	NA	0.59	4		FSCOC
Benzo(b)fluoranthene	12/15	81	1200	222	NA	NA	5.9	2		FSCOC
Benzo(k)fluoranthene	11/15	39	580	107	NA	NA	59	1		FSCOC
Carbazole	7/15	31	460	85	NA	NA	260	1	EPC less than preliminary cleanup goal	NC
Chrysene	12/15	68	1000	185	NA	NA	590	1	EPC less than preliminary cleanup goal	NC
Dibenz(a,h)anthracene	3/15	12	180	33	NA	NA	0.59	1		FSCOC
Indeno(1,2,3-cd)pyrene	12/15	43	630	116	NA	NA	5.9	1		FSCOC
Sediment										
Arsenic	5/5	20	33	33	20	2	20	2	No AOC-related source from soil	NC
Benzo(a)pyrene	2/5	0.30	0.34	0.34	NA	NA	0.59	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) 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 (RVAAP) from the Phase II RI Report for the Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio (USACE 1999).
[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. (Figure 2-4 displays soil locations and Figure 2-5 displays the sediment locations.)
One surface soil sample (RQL-025) had arsenic detected (30 mg/kg) above its preliminary cleanup goal of 15 mg/kg.
One surface soil sample (RQL-026) had lead detected (3710 mg/kg) above its preliminary cleanup goal of 400 mg/kg.
One surface soil sample (RQL-026) had 2,6-dinitrotoluene detected (8.2 mg/kg) above its preliminary cleanup goal of 7.6 mg/kg.
Two surface soil samples had benz(a)anthracene detected above its preliminary cleanup goal of 5.9 mg/kg: RQL-025 (9.3 mg/kg) and RQL-026 (1400 mg/kg).
Four surface soil samples had benzo(a)pyrene detected above its preliminary cleanup goal of 0.59 mg/kg: RQL-025 (6.8 mg/kg); RQL-026 (960 mg/kg); RQL-028 (0.7 mg/kg); and RQL-033 (0.83 mg/kg).
Two surface soil samples had benzo(b)fluoranthene detected above its preliminary cleanup goal of 5.9 mg/kg: RQL-025 (8.3 mg/kg) and RQL-026 (1200 mg/kg).
One surface soil sample (RQL-026) had benzo(k)fluoranthene detected (580 mg/kg) above its preliminary cleanup goal of 59 mg/kg.
One surface soil sample (RQL-026) had carbazole detected (460 mg/kg) above its preliminary cleanup goal of 260 mg/kg.
One surface soil sample (RQL-026) had chrysene detected (1000 mg/kg) above its preliminary cleanup goal of 590 mg/kg.
One surface soil sample (RQL-026) had dibenz(a,h)anthracene detected (180 mg/kg) above its preliminary cleanup goal of 0.59 mg/kg.
One surface soil sample (RQL-026) had indeno(1,2,3-cd)pyrene detected (630 mg/kg) above its preliminary cleanup goal of 5.9 mg/kg.
Two sediment samples had arsenic detected above its preliminary cleanup goal of 20 mg/kg: RQLsd-023 (25.5 mg/kg) and RQLsd-022 (32.5 mg/kg).
[f]Preliminary cleanup goal from Tables 3-3 and 3-4.
[g]Recommendation for COCs for evaluation of remedial alternatives.
AOC = Area of concern.
Detects = Detectable concentrations.
FSCOC = COC for evaluation of remedial alternatives.
NA = Not applicable. Background criteria are used only for naturally occurring inorganic constituents.
NC = Not recommended as a COC for remedial alternative evaluation.

Table 3-9. Surface Water and Groundwater COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at RQL

COC[a]	Freq. of Detect	Measured Concentration (mg/L) Avg.	Max[b]	EPC[c]	Bkg[d] (mg/L)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/L)	Detects > Preliminary cleanup goal[e]	Risk Management Considerations	Rec[g]
Surface Water										
Arsenic	4/9	0.013	0.039	0.022	0.0032	4	0.0089	4	No AOC-related source from soil/sediment	NC
Manganese	9/9	1.6	5.6	5.6	0.39	6	2.6	2	No AOC-related source from soil/sediment	NC
Aldrin	1/3	0.000021	0.000012	0.000012	NA	1	0.000015	0	All detects less than preliminary cleanup goal	NC
Groundwater										
Arsenic	4/6	0.0021	0.0068	0.0068	0	4	0.00057	4	No AOC-related source from soil/sediment	NC
Manganese	6/6	2.3	6.2	6.2	1.3	3	1.3	3	No AOC-related source from soil/sediment	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[th]% upper confidence limit (UCL) or maximum detected concentration depending on number of samples and data distribution.
[d]Final facility-wide background values for the Ravenna Army Ammunition Plant (RVAAP) from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at RVAAP, Ravenna, Ohio* (USACE 1999). Chemicals not detected in background are assigned a value of 0.
[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal.
[f]Preliminary cleanup goal from Table 3-5 and 3-6.
[g]Recommendation for COCs for evaluation of remedial alternatives.
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 remedial alternative evaluation.

3.3.5.4 Summary of COCs for Evaluation of Remedial Alternatives

A summary of COCs for evaluation of remedial alternatives is provided in Table 3-10 for all media.

Table 3-10. Summary of COCs for Evaluation of Remedial Alternatives

Exposure Medium	COC for Evaluation of Remedial Alternatives	
	Security Guard/Maintenance Worker (Restricted Land Use)	**Resident Subsistence Farmer (Unrestricted Land Use)**
Soil	Benz(*a*)anthracene Benzo(*a*)pyrene Benzo(*b*)fluoranthene Dibenz(*a,h*)anthracene Indeno(1,2,*3-cd*)pyrene	Lead Benz(*a*)anthracene Benzo(*a*)pyrene Benzo(*b*)fluoranthene Benzo(*k*)fluoranthene Dibenz(*a,h*)anthracene Indeno(1,2,*3-cd*)pyrene
Sediment	NA	None
Surface Water	NA	None
Groundwater	NA	None

NA = not applicable – receptor not exposed to this medium.

A summary of the preliminary cleanup goals for the COCs identified for evaluation of remedial alternatives is provided below and in Table 3-11 for the representative receptor (Security Guard/Maintenance Worker) and residential land use.

Table 3-11. Summary of COCs and Preliminary Cleanup Goals for Evaluation of Remedial Alternatives for RQL

COC	Preliminary Cleanup Goal (mg/kg)			
	Soil	**Sediment**	**Surface Water**	**Groundwater**
Representative Land Use (Restricted Access – Security Guard/Maintenance Worker)				
Benz(a)anthracene	13	--	--	--
Benzo(a)pyrene	1.3	--	--	--
Benzo(b)fluoranthene	13	--	--	--
Dibenz(a,h)anthracene	1.3	--	--	--
Indeno(1,2,3-cd)pyrene	13	--	--	--
Residential Land Use (Resident Subsistence Farmer)				
Lead	400	--	--	--
Benz(a)anthracene	5.9	--	--	--
Benzo(a)pyrene	0.59	--	--	--
Benzo(b)fluoranthene	5.9	--	--	--
Benzo(k)fluoranthene	59	--	--	--
Dibenz(a,h)anthracene	0.59	--	--	--
Indeno(1,2,3-cd)pyrene	5.9	--	--	--

-- = Chemical is not a COC for evaluation of remedial alternatives for this medium.
COC = Constituent of concern.

3.4 ECOLOGICAL PROTECTION

The ERA performed for RQL is available in the RI Report and summarized in Chapter 2 of this FS. Ohio EPA Levels I and II were performed for RQL and show a number of exceedances of observed concentrations compared to ESVs. The ERA in the RQL RI Report identifies a variety of ecological receptor populations that could be at risk and identifies the COPECs and COECs that could contribute to potential risks from exposure to contaminated media.

The ERA also reported the ecological field work conducted at RQL: ecological reconnaissance of existing vegetation and animal life and Ohio Rapid Assessment for Wetlands that involved a systematic documentation of the wetland quantity and quality that resulted in a numerical score. These findings were published in the RI Report and are summarized in Section 3.4.2 of this FS. The studies document the presence of healthy and functioning terrestrial and aquatic ecosystems.

The risk assessment predictions (e.g., HQs) and field observations were combined in the weight-of-evidence assessments. This combination of information shows that (1) while ESV exceedance and HQs being greater than one suggest risk to plants and selected animals at each AOC, and (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 attainments are being met per Ohio guidance. Because of the combined finding that ecological systems are healthy as well as other reasons, no ecological preliminary cleanup goals are recommended and no remediation for ecological risks is justified at RQL. The rationale for this is explained in detail in Section 3.4.2 and summarized below.

3.4.1 Ecological Preliminary Cleanup Goals for RQL

It is recommended that no quantitative preliminary cleanup goals to protect ecological receptors be developed at RQL. 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 principally on the following weight-of-evidence conclusions:

- Field observations (Level I of Ohio EPA protocol) indicate that there are currently few adverse ecological effects (USACE 2005b), and there is ample nearby habitat to maintain ecological communities at RQL and elsewhere on RVAAP. These observations imply that remediation to protect ecological resources is not necessary.

- The extent of contamination is very limited and; therefore, is not expected to impact ecological resources such as populations and communities.

- Removal of soil or sediment to further reduce any predicted adverse ecological effects would destroy habitat without substantial benefit to the ecological resources at RQL.

Stewardship of the environment will be a major consideration in all phases of planning, design, and implementation of the military mission at RQL. Presently, the inference of ecological risk is based on the risk assessment that used exposure scenarios considered to be protective of the ecological receptors at RQL. Biological measurements showing low quality wetlands near RQL do not corroborate the ecological risk predictions because geographic features of the location preclude development of a high quality wetland. Because ecological risks are not likely to be high, based on AOC reconnaissance and low COPEC concentrations, and remediation would cause habitat destruction, remediation for ecological risk from chemicals is not justified at RQL.

3.4.2 Ecological Preliminary Cleanup Goal Development Weight of Evidence

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 ecological 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 PRGs for ecological receptors at RQL is not included in the Phase I RI Report. The following weight-of-evidence discussions provide input for that decision.

This section provides a rationale for why remediation for protection of ecological receptors, and the associated development of quantitative PRGs, is not warranted for ecological risks at this time. The rationale has the following elements:

- Despite the identification of COPECs at RQL, onsite field studies show a relatively healthy aquatic ecosystem and a poor quality wetland [Level I of the Ohio EPA protocol and Ohio Rapid Assessment for Wetlands (USACE 2005b)].

- No unique ecological resources are found at RQL, and nearby habitat offers home ranges for wildlife.

- The extent of contamination is very limited and; therefore, is not expected to impact ecological resources such as populations and communities.

- No more contaminant migration (beyond what has occurred in the past) is expected to occur from soil to nearby aquatic environments.

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

- Protection of ecological resources would automatically be provided as a benefit of any human health-driven remediation.

Additional information about this dual protectiveness of human health and ecological resources is found in Table 7-1. Each of these elements is explained below regarding the need for ecological PRGs or remediation to protect ecological receptors and a recommendation follows.

3.4.2.1 Ecological Reconnaissance Shows Functioning Ecological System

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

Descriptions of the vegetation and animals found at RQL is included in the RI Report (USACE 2005b). Vegetation consists of old-field communities with patches of forest vegetation. Animals include soil invertebrates, many species of insects, mammals, and birds. However, no known threatened or endangered species or unique natural resources are present at RQL; substantiation of this is found in Chapter 7 (ERA and Natural Resources) of the RI Report for RQL. Therefore, the restricted land use (military mission) would be carried out in an environment in which the low impact would be limited to "normal" ecological resources.

The small aquatic habitat in the bottom of the quarry consists of a pond. The adjacent wetlands were assessed with the Ohio rapid assessment protocol and determined to be of low quality (USACE 2005b). The likely reasons for this are primarily the compromised soil and water features because it is in a quarry or man-made habitat.

3.4.2.2 Nearby Habitats Offer Home Ranges to Wildlife

As stated above, ecological resources are "normal," and nearby terrestrial and aquatic habits are available to receive wildlife. Wildlife can leave and enter adjacent old fields and forest patches and vegetative corridors and other ponds. As implied earlier, RVAAP has thousands of acres of habitat like that at RQL, and wildlife can find new home ranges there; therefore, any lack of protection as a result of not deriving and applying ecological cleanup goals would be minimal because sufficient reservoirs of habitat and wildlife exist to maintain RVAAP-wide ecological communities.

3.4.2.3 Limited Extent of Soil Contamination

Because COPECs are determined based on comparisons of MDCs versus ESVs (as opposed to EPCs versus ESVs) and because the medium-specific ESVs are intended to protect sensitive, multiple receptors, some of which may not be present at FBQ, the identification of COPECs is considered to be a conservative screening process and COPEC concentrations are not necessarily at harmful levels. For example, of the 17 inorganic COPECs in surface soil (0-1 ft BGS) (Table 3-12),

- Four COPECs (calcium, magnesium, potassium, and sodium) do not have ESVs and are generally only toxic at very high concentrations;

- Four COPECs have EPCs less than background criteria, and another seven COPECs have EPCs less than three times background criteria;

- Nine COPECs have MDC greater than ESVs, and numerous detectable concentrations (generally 13 to 15 out of 15 samples) greater than ESV; however, the background criteria for these 9 inorganics is also greater than the ESVs;

- Three inorganics have MDCs greater than ESV, with few detectable concentrations (1 to 3 out of 15 samples) greater than ESV, and ESV less than background; and

- Only lead has several (6) detectable concentrations above the ESV and the ESV is less than the background criterion.

Thus the inorganic COPECs are (1) not highly elevated above background and such a small factor is assumed to mean low exposure and low risk, and (2) ESVs are screening values that are below naturally occurring background concentrations for most metals.

For the 27 organic COPECs in surface soil (0-1 ft BGS):

- Eight COPECs have no ESV;
- Three COPECs have no detected concentrations that exceed ESVs;
- Thirteen COPECs have only one detected concentration (in 15 samples) that exceeds the ESV; and
- Three COPECs have only two detected concentrations (in 15 samples) that exceed the ESV.

These results indicate that the extent of contamination is very limited and; therefore, is not expected to impact ecological resources such as populations and communities.

Table 3-12. COPECs in Surface Soil at RQL Compared to Background and ESV

COPEC	Freq. of Detect	Average Result[a] (mg/kg)	Maximum Detect (mg/kg)	EPC (mg/kg)	Bkg (mg/kg)	Number of Detects >Bkg.	ESV (mg/kg)	Number of Detects >ESV
Aluminum	15/15	10,600	22,100	14,500	17,700	1	600	15
Antimony	11/15	2.2	16	4.1	0.96	4	5	2
Arsenic	15/15	13	30	15	15	1	9.9	13
Cadmium	10/15	1.2	4.7	2.1	0	10	4	1
Chromium	15/15	31	200	52	17	8	0.4	15
Copper	15/15	57	350	94	18	14	14	14
Iron	15/15	26,500	73,000	33,500	23,100	7	200	15
Lead	15/15	303	3710	733	26	12	41	6
Mercury	13/15	0.19	0.89	0.79	0.04	10	0.00051	13

Table 3-12. COPECs in Surface Soil at RQL Compared to Background and ESV (continued)

COPEC	Freq of Detect	Average Result[a] (mg/kg)	Maximum Detect (mg/kg)	EPC (mg/kg)	Bkg (mg/kg)	Number of Detects >Bkg.	ESV (mg/kg)	Number of Detects >ESV
Nickel	15/15	28.5	132	41.8	21	6	30	3
Selenium	2/15	0.79	2	0.975	1.4	1	0.21	2
Vanadium	15/15	20	41	25	31	1	2	15
Zinc	15/15	217	737	313	62	15	8.5	15
1,3-Dinitrobenzene	1/15	0.33	3.9	0.78	NA	NA	0.66	1
2,6-Dinitrotoluene	1/15	0.62	8.2	1.57	NA	NA	1.28	1
2-Methylnaphthalene	8/15	4.5	61	12	NA	NA	3.24	1
Acenaphthylene	2/15	0.57	4.3	1.05	NA	NA	682	0
Anthracene	10/15	67	1,000	185	NA	NA	1,480	0
Benz(a)anthracene	12/15	94	1,400	259	NA	NA	5.21	2
Benzo(a)pyrene	12/15	65	960	177	NA	NA	1.52	2
Benzo(b)fluoranthene	12/15	81	1,200	222	NA	NA	59.8	1
Benzo(ghi)perylene	11/15	44	650	120	NA	NA	119	1
Benzo(k)fluoranthene	11/15	39	580	107	NA	NA	148	1
Bis(2-ethylhexyl)phthalate	6/15	2.0	0.21	0.21	NA	NA	0.93	0
Chrysene	12/15	68	1,000	185	NA	NA	4.73	2
Dibenz(a,h)anthracene	3/15	12	180	33	NA	NA	18	1

[a]Values less than detection limit were set to one-half of the reporting limit in calculation of the average.
Bkg = Background criteria.
COPEC = Constituent of potential ecological concern.
Detects = Detectable concentrations.
EPC = Exposure point concentration.
ESV = Ecological screening value.

Table 3-13. COPECs in Surface Soil at RQL Compared to Background and ESV

COPEC	Freq of Detect	Average Result[a] (mg/kg)	Maximum Detect (mg/kg)	EPC (mg/kg)	Bkg (mg/kg)	Number of Detects >Bkg.	ESV (mg/kg)	Number of Detects >ESV
Fluoranthene	13/15	209	3,100	572	NA	NA	122	1
Fluorene	5/15	30	450	83	NA	NA	30	1
Indeno(1,2,3-cd)pyrene	12/15	43	630	116	NA	NA	109	1
Naphthalene	6/15	7.0	100	18.7	NA	NA	10	1
Phenanthrene	12/15	215	3,200	590	NA	NA	46	1
Pyrene	13/15	202	3,000	554	NA	NA	79	1

[a]Values less than detection limit were set to one-half of the reporting limit in calculation of the average.
Bkg = Background criteria
COPEC = Contaminant of potential ecological concern.
Detects = Detectable concentrations.
EPC = Exposure point concentration.
ESV = Ecological screening value.

3.4.3 No to Low Contaminant Migration

The facility-wide surface water sampling and assessment effort revealed that, in general, surface water quality in the streams at RVAAP was good to excellent with few exceedances of Ohio Water Quality Standards criteria. Intact riparian buffers around the streams contributed to good habitat and absence of substantial silt deposits. Evidence suggests that an additional remedial investigation effort, on an installation-wide basis, of the streams included in this assessment is not warranted. Contamination is not currently present in the sediments in the sampled reaches, and the surface water appears to be similarly free of contaminants. However, this does not preclude investigating surface water and sediment on an individual basis as required by Ohio EPA.

At RQL, no offsite contaminant migration is possible because the pond lies in a depression with no streams to carry contaminants from the AOC.

3.4.4 Mitigation Trade-off of Reducing Potential Chemical Risk but Harming Environment

There is a trade-off of two kinds of risk: physical alterations and residual contamination. The localized ecosystem either can have clean soil because of removal and replacement but have a highly disturbed habitat as a result, or it can have exposure to contaminants in the soil in a habitat that is minimally disturbed. In some cases, it may 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 other cases, especially when human health is threatened, it is necessary to alter or destroy habitat to prevent exposure to soil contaminants (Suter et al. 1995). In the case of RQL activities, the military mission does not include 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 soil because COPEC concentrations are not necessarily at harmful levels, as noted previously. This small factor means that concentrations are not likely to be an exposure and risk issue. When a human health goal is chosen, it offers duel protectiveness to human health and ecological resources after any habitat disturbance has been reversed by ecological succession as environmental management.

3.5 FATE AND TRANSPORT ASSESSMENT OF COCS IN SOILS

Impacted soils at RQL also were evaluated to assess their potential to impact groundwater both at the AOC (residential land use exposure scenario) and at an exposure point downgradient of the AOC (Security Guard/Maintenance Worker land use exposure scenario) to ensure residual concentrations in soils are protective of groundwater under both potential land use exposure scenarios. The process for identifying soil constituents potentially impacting groundwater is detailed in Appendix 3A and summarized below:

- The assessment started with the soils CMCOPCs and CMCOCs identified in the fate and transport evaluation conducted in the RI.

- Constituents were assessed across media using AOC-specific analytical data and background information to refine the list of soils CMCOPCs and CMCOCs.

- Constituents were evaluated further, if necessary, using a refined version of the modeling performed in RIs. The refinements include updated source areas, updated source concentrations, and an updated depth to the water table (averaged over the new source areas) to further define potential for impacted soils to leach to groundwater.

3.5.1 Refined Chemical Impacts to Groundwater Assessment

Based on the results of the Phase I RI for the RQL, nine constituents are evaluated for potential impacts in groundwater beneath the source and three constituents are evaluated for potential impacts to groundwater at downgradient receptors. Upon further analysis, none of these constituents were predicted or identified to impact groundwater at the AOC or downgradient of the AOC, as summarized below. In addition, the closure plan for the RQL landfill required groundwater monitoring. Therefore, any constituents of concern will be evaluated over a minimum of twenty years.

- Antimony is removed from further consideration of future groundwater impacts at RQL because there are no detections in surface water or groundwater in excess of the MCL from impacted soils that are in periodic contact with surface water/groundwater.

- Arsenic is removed from further consideration of future groundwater impacts because there is only a single exceedance of background; both the source concentration and the EPC at RQL are less than subsurface soil background; and observed groundwater results are below the MCL. Modeling results indicate background levels of arsenic in soils may result in groundwater impacts in excess of the MCL.

- Detectable concentrations of chromium occur in shallow soils, yet groundwater and surface water detectable concentrations are well below the MCL. A qualitative evaluation of the multi-increment sample results for chromium indicates concentrations are similar to the RVAAP subsurface soil background value (27.2 mg/kg) with a maximum detected concentration of 27.5 mg/kg. Therefore, chromium is removed from further consideration of future groundwater impacts.

- All detections of manganese in soil samples were below background values; therefore manganese is removed from further consideration of future groundwater impacts.

- 1,3-DNB: RI SESOIL source load modeling predicted the maximum impact in 2 years. Given the AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. 1,3-DNB is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 2 years (i.e., maximum impact has likely passed), and the observed groundwater levels are well below the MCL.

- 2,6-DNT: RI SESOIL source load modeling predicted the maximum impact in 3 years. Given the AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. 2,6-DNT is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 3 years, and 2,6-DNT has not been detected in either surface water or groundwater.

- Nitroglycerin: RI SESOIL source load modeling predicted the maximum impact in 6 years. Given the AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. Nitroglycerin is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 6 years (i.e., maximum impact has likely passed), and nitroglycerin has not been detected in surface water or recent groundwater samples (2003-2004) at RQL.

- RDX: RI SESOIL source load modeling predicted the maximum impact in 2 years. Given the AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. RDX is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 2 years (i.e., maximum impact has likely passed), and RDX has not been detected in surface water or recent groundwater samples (2003-2004) at RQL.

- Carbazole is removed from further consideration of future groundwater impacts at RQL because there are no detections in surface water or groundwater from impacted soils that are in periodic contact with surface water/groundwater.

3.5.2 Refined AOC-Specific Modeling Results

Based on analyses of the fate and transport assessment performed in support of the RI for RQL, no COCs were identified for further analysis using the SESOIL/AT123D models previously developed with refined input parameters.

Impacted soils at RQL are not predicted to impact underlying groundwater beneath the AOC. Therefore, soil remediation for protection of groundwater is not required at RQL.

3.6 COCs FOR REMEDIAL ALTERNATIVE EVALUATION AT RQL

The final list of COCs for evaluation of remedial alternatives were identified for RQL in the previous sections (Sections 3.3, 3.4, and 3.5) based on risk management considerations including:

- Comparison of EPC to preliminary cleanup goals concentrations (including background concentrations);

- Comparison of EPC to upgradient concentrations for sediment, surface water, and groundwater;

- Consideration of soil 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.

A summary of COCs and media identified for evaluation of remedial alternatives is provided below for RQL. COCs identified in soils/dry sediments will be carried forward for evaluation of remedial alternatives in Sections 5, 6, and 7 of this FS Report. COCs identified in aqueous media (i.e., groundwater, surface water, and wet sediment) will be carried forward for evaluation of remedial options in Chapter 5 of this FS Report. Those media where no COCs were identified for both the representative receptor (Security Guard/Maintenance Worker) and residential land use are recommended for no further action with respect to these media.

Five PAHs are identified for evaluation of remedial alternatives for soil for the Security Guard/Maintenance Worker at RQL. Six PAHs and one metal are recommended for evaluation of remedial alternatives for soil for residential land use (Table 3-14).

COCs identified in soils/dry sediments (Table 3-14) will be carried forward for evaluation of remedial alternatives in Sections 5, 6, and 7 of this FS Report.

Table 3-14. Summary of COCs at RQL

Soil	Sediment	Surface Water	Groundwater
Representative Land Use (Restricted Access – Security Guard/Maintenance Worker)			
Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	--	--	--
Residential Land Use (Resident Subsistence Farmer)			
Lead Benz(a)anthracene Benzo(a)pyrene Benzo(b)fluoranthene Benzo(k)fluoranthene Dibenz(a,h)anthracene Indeno(1,2,3-cd)pyrene	--	--	--

-- = No COCs identified for evaluation of alternatives in the Feasibility Study for this medium.
COC = Constituent of concern.

3.7 EXTENT AND VOLUME CALCULATIONS

Estimated volumes of impacted soils and/or dry sediments were calculated for RQL where COCs in these media were identified (Section 3.6) to be evaluated further in the FS. Analytical data collected during the remedial investigations were used to generate a three-dimensional volume model for each final AOC-related COC using a geologic modeling and geospatial visualization program. The volumes of soils exceeding preliminary cleanup goals for Security Guard/Maintenance Worker and Resident Subsistence Farmer land use are summarized in Table 3-15. Supplemental information and data are presented in Appendix 3B.

Table 3-15. Estimated Volume of Impacted Soils

AOC/Scenario	Surface Area (ft^2)	In situ		In situ with Constructability[a]		Ex situ[a,b]	
		Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
RQL Security Guard/Maintenance Worker Land Use – Soil	7,621	7,621	282	9,526	353	11,432	423
RQL Resident Subsistence Farmer Land Use – Soil	14,683	14,683	543	18,354	679	22,025	815

[a] Includes 25% constructability factor.
[b] Includes 20% swell factor.
AOC = Area of concern.
RQL = Ramsdell Quarry Landfill.

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4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Agencies responsible for remedial actions under CERCLA must ensure selected remedies meet ARARs. This chapter describes the proposed ARARs for RQL.

4.1 INTRODUCTION

CERCLA Sections 121(d)(1) and (2) provide that remedial actions selected for a site must attain a degree of cleanup of hazardous substances, pollutants, and contaminants that: (1) assures protection of human health and the environment; and (2) complies with ARARs. ARARs are developed in accordance with the statutory and regulatory provisions set forth in CERCLA and the National Contingency Plan (NCP).

A remedial action will comply with ARARs if the remedial action attains the standard established in the ARAR for a particular hazardous substance. When a hazardous substance, pollutant, or contaminant will remain onsite at the completion of a remedial action, then that substance must meet any limit or standard set forth in any legally ARAR, criteria, or limitation under a federal environmental law. These standards apply unless such standard, requirement, criteria, or limitation is waived in accordance with CERCLA Section 121(d)(4). Any promulgated standard, requirement, criteria, or limitation under a state environmental or facility citing law that is more stringent than any federal standard, requirement, criteria, or limitation, and that has been identified by the state in a timely manner, can be an ARAR as well.

Regulatory language interpreting and implementing the statutory directive is found in the NCP. One provision, 40 *Code of Federal Regulations (CFR)* Section 300.400(g), provides that the lead agency (US Army) and support agency (Ohio EPA) shall identify applicable requirements based upon an objective determination of whether the requirement specifically addresses a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Under 40 *CFR* Section 300.430(e), the lead agency has the ultimate authority to decide what requirements are ARARs for the potential remedial activities.

Identifying ARARs involves determining whether a requirement is legally applicable, and if it is not legally applicable, then whether a requirement is relevant and appropriate. Individual ARARs for each site must be identified on a site-specific basis. Applicable requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site (40 *CFR* Section 300.5).

If it is determined that a requirement is not legally applicable to a specific release, the requirement may still be relevant and appropriate to the circumstances of the release. Determining whether a rule is relevant and appropriate is a two-step process that involves determining whether the rule is relevant, and, if so, whether it is appropriate. A requirement is relevant if it addresses problems or situations sufficiently similar to the circumstances of the remedial action contemplated. It is appropriate if its use is well suited to the site.

In addition to ARARs, the lead and support agencies may identify other advisories, criteria, or guidance to be considered for a particular release. The "to be considered" (TBC) category consists of advisories, criteria, or guidance that were developed by USEPA, other federal agencies, or states that may be useful in developing CERCLA remedies. TBCs will be considered as guidance or justification for a standard used in the remediation if no other standard is available for a situation to help determine the necessary level of cleanup for protection of health or the environment. This may occur if no ARAR is available for a particular COC, or if there are multiple contaminants and/or multiple pathways not considered when establishing the standards in the ARAR so that use of the ARAR does not allow the remedial action to be protective of human health or the environment.

While onsite actions must comply with both applicable and relevant and appropriate requirements, offsite actions must comply with only applicable requirements. Also, a determination of relevance and appropriateness may be applied to only portions of a requirement, so that only parts of a requirement need be complied with, whereas a determination of applicability is made for the requirement as a whole, so that the entire requirement must be complied with.

CERCLA provides for a permit waiver for remedial actions that are conducted onsite and in accordance with NCP. Although the administrative requirement of permits has been waived by the statute, substantive requirements of rules that would otherwise be enforced through permits are still applicable. The Ohio EPA Division of Emergency and Remedial Response (DERR) has addressed this issue in two policies, one in final form and one in draft form. The policy in final form, Final Policy Number DERR-00-RR-001, ARARs, July 30, 1998, states that: "…cleanup projects will not be subject to the administrative requirements of permits, including permit applications, public notice, etc.," particularly when the cleanup project is governed by an enforcement order. The policy in draft form, Draft Policy Number DERR-00-RR-034, Use of ARARs in the Ohio EPA Remedial Response Program, September 2, 2003, states that: "It has been DERR's policy to require responsible parties to acquire and comply with all necessary permits, including all substantive and administrative requirements." Permit waivers are specifically addressed in Section VII. General Provisions (Paragraph No. 12e) of the DFFO:

"It is Ohio EPA's position that if state law related to a remedial or removal action requires a permit, then a permit must be acquired in accordance with CERCLA Section 120(a)(4). It is Respondent's position that these Orders implement a CERCLA-based remediation program and that a permit is not required in accordance with CERCLA Section 121(e). The Parties agree that the remedial or removal actions anticipated at the RVAAP are not of the type that routinely require a permit under state law. If Ohio EPA determines that a permit is required for a particular remedial or removal action at the RVAAP, the Parties will meet and attempt in good faith to resolve to [sic] this issue."

Any remedial response action at RVAAP must be conducted in accordance with the DFFOs, which provide that, irrespective of ARARs, "all activities undertaken … pursuant to these Orders shall be performed in accordance with the requirements of CERCLA, the NCP, and all other applicable federal and state laws and regulations."

4.2 POTENTIAL ARARS FOR RQL

USEPA classifies ARARs as chemical-specific, action-specific, and location-specific to provide guidance for identifying and complying with ARARs (USEPA 1988):

- Chemical-specific ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, allow numerical values to be established. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment (USEPA 1988).

- Action-specific ARARs are rules, such as performance or design or other activity-based rules, that place requirements or limitations on actions.

- Location-specific ARARs are rules that place restrictions on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations (USEPA 1988).

As explained in the following paragraph, rules from each of these categories are ARARs only to the extent that they relate to the degree of cleanup.

CERCLA Section 121 governs cleanup standards at CERCLA sites. ARARs originate in the subsection of CERCLA that specifies the degree of cleanup at each site, CERCLA Section 121(d). In Section 121(d)(2), CERCLA expressly directs that ARARs are to address specific contaminants of concern at each site, specifying the level of protection to be attained by any chemicals remaining at the site. CERCLA Section 121(d)(2) provides that with respect to hazardous substances, pollutants, or contaminants remaining onsite at the completion of a remedial action, an ARAR is:

> "any standard, requirement, criteria, or limitation under any Federal environmental law … or any promulgated standard, requirement, criteria, or limitation under a State environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria, or limitation"

CERCLA Section 121(d)(2) further provides that the remedial action attain a level of control established in rules determined to be ARARs.

In some cases, most ARARs will be chemical-specific. Action- or location-specific requirements will be ARARs to the extent that they establish standards addressing contaminants of concern that will remain at the site. In addition, CERCLA Section 121(d)(1) directs that remedial actions taken to achieve a degree of cleanup that is protective of human health and the environment are to be relevant and appropriate under the circumstances presented by the release. Accordingly, any chemical-, action-, or location-specific requirements will be ARARs to the extent that they ensure that the degree of cleanup will be protective of human health and the environment under the circumstances presented by the release. An evaluation of the regulatory requirements has shown none are chemical-specific ARARs, for the contamination identified in various media at the RQL.

In summary, chemical-, action-, or location-specific requirements will be ARARs to the extent that they establish standards protective of human health and the environment for chemicals that will remain onsite after the remedial action, and to the extent that they ensure a degree of cleanup that is protective of human health and the environment under the circumstances presented by the release.

4.2.1 Potential Action-Specific ARARs for Soils

If soil contamination is determined to be Resource Conservation and Recovery Act (RCRA) hazardous material, certain hazardous waste requirements are triggered. Some RCRA requirements prescribe standards for treatment of hazardous materials. These requirements are generally not considered to be chemical specific ARARs because they do not relate directly to the degree of cleanup or to specific chemicals but rather to the method used to obtain the degree of cleanup. Some RCRA requirements prescribe standards for disposal of hazardous materials. Although these requirements are not chemical-specific ARARs, they are potential action-specific ARARs when the remedial action includes the generation and subsequent management of environmental media that are, or contain, a hazardous waste. Standards that directly address land disposal may be potential ARARs. These are: (1) land disposal requirements (LDRs) prohibiting disposal of specific chemicals until they are treated to a protective level, and (2) minimum technical requirements (MTRs) for land disposal units.

USEPA cautions that LDRs should not be used to determine site-specific cleanup levels for soils (USEPA 2002). The purpose of LDRs is to require appropriate treatment of RCRA hazardous wastes that are to be land disposed of to minimize short and long-term threats to human health or the environment. Performing treatment to meet certain standards is different from the CERCLA approach to remediation, which is analyzing risk and then developing soil cleanup standards based on the risk present, and may result in soil cleanup levels that are different from those of a risk-based approach. Nevertheless, if RCRA hazardous materials are managed in a way that generates RCRA hazardous waste, and if that waste is land disposed of onsite, then the material must meet the standards established in the LDRs.

In order for LDRs to be triggered as potential ARARs, RCRA hazardous waste must be present. This requires: (1) that soil contain contaminants that either derive from RCRA listed wastes or that exhibit a characteristic of RCRA hazardous waste; and (2) that soils are managed in a way that "generates" hazardous waste. Several methods of soil management that do not "generate" hazardous waste and so do not trigger LDRs are available for use. These methods are: the AOC approach, use of a staging pile, use of a storage or treatment corrective action management unit (CAMU), or use of a temporary unit (TU).

If soils are managed in a manner that generates hazardous waste, such as removing soil to an above-ground container, and then redepositing the soil within the land unit for disposal, then LDRs become potential ARARs. LDRs attach to the waste at the time that it is removed from the unit under an AOC approach, or at the time that the soil is excavated and lifted out of the unit. Potential LDR ARARs in Ohio are variances from treatment standards at OAC Section 3745-700-44, LDR standards for contaminated debris at OAC Section 3745-47, Universal Treatment Standards (UTS) at OAC Section 3745-270-48, and Alternative Standards for Contaminated Soil at OAC Section 3745-270-49.

Ohio has adopted the alternative soil treatment standards as promulgated by USEPA in its Phase IV LDR rule, effective August 1998. The rules provide that if RCRA hazardous wastes are present, then the material must meet either one of two sets of LDRs before being disposed of in a land unit: (1) the UTS; or (2) the contaminated soil (technology-based treatment) standards promulgated in Phase IV of the LDRs, whichever is greater. Or, if a generator so chooses, he may use the generic treatment standards at OAC Section 3745-270-40 which apply to all hazardous wastes. Only the alternative soil treatment standards are explained in this document. Under the alternative soil treatment standards, all soils subject to treatment must be treated as follows:

1. For non-metals, treatment must achieve 90% reduction in total constituent concentration (primary constituent for which the waste is characteristically hazardous as well as for any organic or metal underlying hazardous constituent [UHC]), subject to item 3 below;

2. For metals and carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in constituent concentrations as measured in leachate from the treated media (tested according to the Toxicity Characteristic Leaching Procedure (TCLP) or 90% reduction in total constituent concentrations (when a metal removal treatment technology is used), subject to item 3 below:

3. When treatment of any constituent subject to treatment to a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. This is commonly referred to as "90% capped by 10xUTS."

4. USEPA and Ohio EPA have established a site-specific variance from the soil treatment standards, which can be used when treatment to concentrations of hazardous constituents greater (i.e., higher) than those specified in the soil treatment standards minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the soil treatment standards. Any variance granted cannot rely on capping, containment, or other physical or institutional controls.

If CAMUs are used as disposal units at RQL, then the design and treatment standards established at OAC Section 3745-57-72 will be potentially relevant and appropriate to the response action. Only CAMU-eligible waste can be disposed of in a CAMU. CAMU-eligible waste includes hazardous and non-hazardous waste that are managed for implementing cleanup, depending on the Director’s approval or prohibition of specific wastes or waste streams. Use of a CAMU for disposal does not trigger LDRs or MTRs as long as the standards specified in the rule are observed. The Director will incorporate design and treatment standards into a permit or order. Design standards include a composite liner and a leachate collection system that is designed and constructed to maintain less than a 30 cm depth of leachate over the liner. A composite liner entails a system consisting of two components; each component has detailed specifications and installation requirements. The Director may approve alternate requirements if he can make the findings specified in the rule. Treatment standards are similar to LDR standards for contaminated soil, although alternative and adjusted standards may be approved or required by the Director, as long as the adjusted standard is protective of human health and the environment.

Table 4-1. Potential Action ARARs for Disposal of RCRA Hazardous Waste

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Soil Contaminated with RCRA Hazardous Waste OAC Section 3745-400-49 OAC Section 3745-400-48 UTS	These rules prohibit land disposal of RCRA hazardous wastes subject to them, unless the waste is treated to meet certain standards that are protective of human health and the environment. Standards for treatment of hazardous contaminated soil prior to disposal are set forth in the two cited rules. Use of the greater of either technology-based standards or UTS is prescribed.	LDRs apply only to RCRA hazardous waste. This rule is considered for ARAR status only upon generation of a RCRA hazardous waste. If any soils are determined to be RCRA hazardous, and if they will be disposed of onsite, then this rule is potentially Applicable to disposal of the soils.	All soils subject to treatment must be treated as follows: 1) For non-metals, treatment must achieve 90% reduction in total constituent concentration (primary constituent for which the waste is characteristically hazardous as well as for any organic or metal UHC), subject to 3) below; 2) For metals and carbon disulfide, cyclohexanone, and methanol, treatment must achieve 90% reduction in constituent concentrations as measured in leachate from the treated media (tested according to the TCLP or 90% reduction in total constituent concentrations (when a metal removal treatment technology is used), subject to 3) below: 3) When treatment of any constituent subject to treatment to a 90% reduction standard would result in a concentration less than 10 times the UTS for that constituent, treatment to achieve constituent concentrations less than 10 times the UTS is not required. This is commonly referred to as "90% capped by 10xUTS."

Table 4-1. Potential Action ARARs for Disposal of RCRA Hazardous Waste (continued)

Media and Citation	Description of Requirement	Potential ARAR Status	Standard
Debris Contaminated with RCRA Hazardous Waste OAC Section 3745-400-49 OAC Section 3745-400-47	These rules prescribe conditions and standards for land disposal of debris contaminated with RCRA hazardous waste. Debris subject to this requirement for characteristic RCRA contamination that no longer exhibits the hazardous characteristic after treatment does not need to be disposed of as a hazardous waste. Debris contaminated with listed RCRA contamination remains subject to hazardous waste disposal requirements.	If RCRA hazardous debris is disposed of onsite, then these rules are potentially applicable to disposal of the debris.	Standards are extraction or destruction methods prescribed in OAC Section 3745-400-47. Treatment residues continue to be subject to RCRA hazardous waste requirements.
Soils/Debris Contaminated with RCRA Hazardous Waste – Variance OAC Section 3745-400-44	The Director will recognize a variance approved by the USEPA from the alternative treatment standards for hazardous contaminated soil or for hazardous debris.	Potentially applicable to RCRA hazardous soil or debris that is generated and placed back into a unit and that will be land disposed of onsite.	A site-specific variance from the soil treatment standards can be used when treatment to concentrations of hazardous constituents greater (i.e., higher) than those specified in the soil treatment standards minimizes short- and long-term threats to human health and the environment. In this way, on a case-by-case basis, risk-based LDR treatment standards approved through a variance process could supersede the soil treatment standards.
Soils Disposed of in a CAMU OAC Section 3745-57-53	Only CAMU-eligible waste can be disposed of in a CAMU. CAMU-eligible waste includes hazardous and non-hazardous waste that are managed for implementing cleanup, depending on the Director's approval or prohibition of specific wastes or waste streams. Use of a CAMU for disposal does not trigger LDRs or MTRs as long as the standards specified in the rule are observed. The Director will incorporate design and treatment standards into a permit or order.	Potentially applicable to RCRA hazardous waste that is disposed of in a CAMU.	Design standards include a composite liner and a leachate collection system that is designed and constructed to maintain less than a thirty centimeter depth of leachate over the liner. A composite liner means a system consisting of two components; each of which has detailed specifications and installation requirements. The Director may approve alternate requirements if he can make the findings specified in the rule. Treatment standards are similar to LDR standards for contaminated soil, although alternative and adjusted standards may be approved or required by the Director, as long as the adjusted standard is protective of human health and the environment. Treatment standards are de facto cleanup standards for wastes disposed of in a CAMU.

ARAR = Applicable and relevant or appropriate requirements.
CAMU = Corrective Action Management Unit.
LDR = Land Disposal Restrictions.
MTR = Minimum technical requirements.
OAC = Ohio Administrative Code.
RCRA = Resource Conservation and Recovery Act.
TCLP = Toxicity characteristic leaching procedure.
UHC = Underlying Hazardous Constituent.
UTS = Universal Treatment Standard.

4.2.2 Potential Location-Specific ARARs for Solid Wastes, RCRA Hazardous Wastes, Construction & Demolition Debris, Wastes, or Clean Fill

Location requirements include those established for potential remedial activities conducted within wetlands or within a floodplain area, or with respect to threatened and endangered species. Generally, for wetlands and floodplains, rules require that alternatives to remedial activity within the sensitive area be pursued, and if that is not feasible, then adverse effects from any actions taken within the sensitive area be mitigated to the extent possible. These requirements do not relate to specific chemicals, nor do they further the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances. Rather, their purpose is to protect the sensitive areas to the extent possible. Under CERCLA Section 121(d), relevance and appropriateness are related to the circumstances presented by the release of hazardous substance, with the goal of attaining a degree of cleanup and control of further releases that ensures protection of human health and the environment.

Rules ensuring protection of sensitive resources do not represent requirements that are relevant and appropriate to circumstances presented by the release of hazardous substance, with a goal of attaining a degree of cleanup and control of further releases that ensure protection of human health and the environment. Location requirements for wetlands and floodplains do not relate to the degree of cleanup as much as they relate to protection of these sensitive areas from the effects of remedial activities. This purpose of the rule requirements does not address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site as an ARAR; that is, the rule requirements are not sufficiently relevant and appropriate under CERCLA Section 121(d) as related to the circumstances of the release, degree of cleanup, or protectiveness of remedial action, to include these requirements as ARARs.

The Endangered Species Act (ESA) exists to protect the habitat or body of flora and fauna that are threatened or endangered. Once again, these rules do not relate to specific chemicals, nor do they further the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances. The purpose of these rules is to protect sensitive areas and plant and animal life to the degree possible. This purpose does not address problems or situations sufficiently similar to those encountered at the CERCLA site that its use is well suited to the particular site as an ARAR; that is, the rule requirements are not sufficiently relevant and appropriate under CERCLA Section 121(d) as related to the circumstances of the release, degree of cleanup, or protectiveness of the remedial action, to include these requirements as ARARs.

Having determined that these requirements are not ARARs, any action taken by the Federal Government must be conducted in accordance with requirements established under the National Environmental Policy Act (NEPA), ESA, and federal and state wetlands and floodplains construction and placement of materials considerations, even though these laws and rules do not establish standards, requirements, limitations, or criteria relating to the degree of cleanup for chemicals remaining onsite at the close of the response action.

5.0 TECHNOLOGY TYPES AND PROCESS OPTIONS

This chapter describes the identification and screening of technology types and process options for COCs in impacted media at RQL (as summarized in Section 3.6). The purpose of the identification and screening is to determine suitable technologies and process options that can be assembled into remedial alternatives capable of mitigating the existing contamination. The *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (USEPA 1988) established a structured process for this purpose. A series of steps is used to reduce the universe of potential remedial options to a smaller group of viable ones, from which a final remedy may be selected:

- Identifying general classes of response actions, or general response actions (GRAs), suitable for impacted media at RQL (Section 5.1).

- Identifying technologies and process options applicable to the general response actions and performing an initial screening for soils/dry sediment (Section 5.2).

- Performing a detailed evaluation of the screened technologies and process options for soils and dry sediment in terms of effectiveness, implementability, and cost (Section 5.3).

The Federal Remediation Technologies Roundtable (FRTR) has provided guidance for the evaluation of remedial technologies. FRTR provides a screening matrix that assesses the effects potential technologies have on the types of contaminants. This guidance was used as a point of reference throughout this initial screening of technologies.

5.1 GENERAL RESPONSE ACTIONS

This section describes the GRAs and remedial technologies that are potentially applicable at RQL. GRAs are actions that will satisfy the RAOs (Section 3.1) for a specific medium, and may include various process options. GRAs are not remedial alternatives but are potential components of remedial alternatives. Proposed remedial alternatives are presented in Chapter 6 and include GRAs or combinations of the GRAs presented below. GRAs were selected based on the media of concern (soil/dry sediment). GRAs include no action, land use controls, monitoring, containment, removal, treatment, and disposal/handling.

5.1.1 No Action

In this GRA, no action would be undertaken to reduce any hazard to human health or the environment. Any current actions, restrictions, or monitoring would be discontinued. This action complies with the CERCLA requirement to provide an appropriate option or component of a remedial alternative if no unacceptable risks are present and to provide a baseline against which other alternatives can be compared.

5.1.2 Land Use Controls and 5-Year Reviews

Generally, land use controls reduce the potential for exposure to contaminants, but do not reduce contaminant volume or toxicity. These controls are utilized to supplement and affect the engineering component(s) of a remedy (e.g., treatment, removal, etc.) during short- and long-term implementation.

The primary goal of land use controls is to restrict the use of, or limit access to, real property using physical, legal, and/or administrative mechanisms to ensure protectiveness of the remedy. Particular land use controls under consideration at RQL include measures that will restrict land use changes over the long-term, such as governmental controls and enforcement tools. Governmental controls could include a Facility Master Plan and installation-specific regulations to manage property and enforce management strategies, while enforcement tools may involve administrative orders or consent decrees. Land use controls can be used to supplement engineering controls; however, land use controls are not to be used as the sole remedy at a CERCLA site unless the use of active measures such as treatment and/or containment of source material are determined to not be practicable [(40 *CFR* Section 300.430(a)(1)(iii)(D)].

If land use controls are selected as a component of a remedial alternative achieving Security Guard/Maintenance Worker land use, the effectiveness of the remedy must undergo 5-year reviews. The primary goal of the 5-year reviews is to evaluate the implementation and performance of a remedy to determine if the remedy is or will be protective of human health and the environment. The 5-year reviews may be discontinued upon the AOC achieving preliminary cleanup goals for residential use and unrestricted release.

5.1.3 Containment

Containment can effectively reduce contaminant mobility and the potential for exposure. However, containment actions do not reduce contaminant volume or toxicity. When consolidation is used in conjunction with containment, the overall area of contamination is reduced, thereby reducing the area of potential exposure to individuals. The primary containment technology considered for soils and sediments at RQL is capping with consolidation. Capping involves covering an area with a low-permeability material (e.g., native soil, clay, concrete, asphalt, synthetic liner, or multi-layered) to reduce infiltration of water and the migration of COCs.

5.1.4 Removal

Removal of impacted soils/dry sediments would reduce the potential for long-term human and environmental exposure. For example, impacted soil could be excavated and disposed of either onsite in a designated location or offsite in an appropriately licensed disposal facility. Excavation would minimize long-term direct human contact with and the local migration of impacted material.

5.1.5 Treatment

The treatment options evaluated for impacted soils/dry sediments at RQL include various physical, chemical, biological, and thermal technologies. Physical processes involve either physically binding the contaminants to reduce their mobility or the potential for exposure or extracting them from a medium to reduce volumes. Chemical treatment processes add chemicals (in situ or ex situ) to react with contaminants to reduce their toxicity or mobility. Biological treatment involves using microbes to degrade or concentrate contaminants. Thermal treatment such as incineration uses high temperatures to volatilize, decompose, or melt contaminants.

5.1.6 Disposal and Handling

Disposal and handling of soils and sediments would involve the permanent and final placement of waste materials in a manner that protects human health and the environment. Soils and dewatered sediments could be disposed of onsite in an engineered facility, or offsite in a permitted or licensed facility such as a regulated landfill. Similarly, concentrated waste resulting from treatment processes could be disposed of either onsite in a permanent disposal cell or offsite in an approved disposal facility. Transportation could be accomplished using a variety of modes. Truck, railcar, and/or barge transportation could be used to move soils onsite or ship waste materials offsite.

5.2 INITIAL SCREENING OF TECHNOLOGIES ~ SOILS/DRY SEDIMENTS

This section describes the identification and initial screening of potential technologies to achieve soil RAOs at RQL. Technology types and process options for RQL were selected on the basis of their applicability to the environmental media of interest (e.g., soil and sediment). Process options were either retained or eliminated from further consideration on the basis of technical implementability and effectiveness with respect to soils and sediment COCs. Results of the initial technology screening are summarized in Table 5-1 (at the end of this chapter).

5.2.1 No Action

No action would be taken to implement remedial technologies to reduce any hazard to human health or the environment. Any current actions, restrictions, or monitoring would be discontinued. This action complies with the CERCLA requirement to provide an appropriate option or component of a remedial alternative if no unacceptable risks are present. The No Action technology shall be retained as a process option to be further evaluated.

5.2.2 Land Use Controls and Monitoring

Actions being considered for this RQL FS include land use controls and 5-year reviews of the AOC, excluding the closed landfill. Land use controls are legal, administrative, and physical, mechanisms employed to restrict the use of, or limit access to, real property to prevent or reduce risks to human health and the environment. The implementability of these mechanisms is contingent on:

- The entity assuming responsibility for initiating, implementing, and maintaining the controls;
- The arrangements made between property owners in different governmental jurisdictions and the authority of local governments; and
- Specific characteristics of the AOC.

Legal impediments and costs affect implementability and schedules. NCP has outlined criteria to evaluate when the use of land use controls would be acceptable as a component of a remedial alternative. Sites containing residual contamination above acceptable concentrations for residential land use require 5-year reviews to determine whether the integrity of the controls remains intact. When the AOC achieves preliminary cleanup goals that allow for unlimited use and unrestricted exposure, then the 5-year reviews may be discontinued.

5-year reviews will include the review of results from any required remedy effectiveness monitoring activities, conducting of interviews to provide additional information about the AOC's status, and inspections. The sampling and monitoring plans would be tailored to the selected remedial alternative so that monitoring objectives are fulfilled. An adequate monitoring program includes periodic sampling of all media that could be affected by the continued presence of contaminants. Environmental monitoring would be required for any remedial alternative that does not allow for residential land use.

All land use controls and 5-year review options will be retained for further evaluation.

5.2.3 Containment

Containment actions prevent or minimize contaminant migration and eliminate exposure pathways. Contaminated medium is neither chemically nor physically changed nor are the volumes of contaminated media reduced. The containment action considered for impacted soils and sediment at RQL is capping. Capping can reduce surface water infiltration through contaminated media and minimize the release of dust and vapors to the atmosphere. Process options consist of varying cap construction materials of native soil, clay, synthetic liner, multi-layered, asphalt, and concrete.

Native and/or clay soils can be used to construct a cap to provide an exposure barrier to contaminated soils and dry sediment. In conjunction with surface controls, such a cap can be effective in reducing contaminant migration by wind and water erosion. However, soil caps are susceptible to weather effects including cracking. Synthetic liners or multi-layered caps of different media would not be as susceptible to cracking and also would provide adequate exposure barriers. Asphalt and concrete caps have similar limitations as native and clay soil caps if not properly maintained. Existing building slabs and paved surfaces can be effective in reducing direct human contact and wind and water erosion.

Capping is a mature, commercially available technology for remediation and is applicable to all COCs at RQL. Where remedial treatments are not recommended (based on the evaluation of effectiveness, implementation, and cost), permanent caps may provide sustained isolation of contaminants and prevent the mobilization of soluble compounds over the long term and eliminate exposure pathways. Capping tends to be less expensive than other remedial technologies. Simple compacted soil covers or asphalt/concrete covers are far more susceptible to weathering (erosion, ultraviolet light, and freeze/thaw cycle). Therefore, capping systems require periodic inspection and repair to maintain effectiveness. Capping systems that utilize synthetic liners or a combination of different media (e.g., RCRA caps) would be less susceptible to cracking due to climatic effects. Capping does not lessen toxicity, mobility, or volume of hazardous wastes, but does mitigate vertical migration. In addition, the presence of a cap may hinder any additional soil treatment should the contaminated soil be found to require treatment at a later date.

Capping is not retained as an option for RQL due to AOC specific conditions. RQL is subject to periodic flooding, rendering cap installation, and maintenance impractical.

5.2.4 Removal

Removing contaminated soil and dry sediment involves bulk excavation techniques via conventional excavation equipment. The techniques utilized are dependent upon the areas and locations to be excavated. Large mechanical excavators would be used for easily accessible areas. Where space is limited, smaller mechanical devices or hand tools may be required. Excavation would require the use of dust and surface runoff controls to ensure the safety of workers and the general public. Runoff controls are especially important for any areas draining to a wetland. Excavated soils and dry sediments can then be transported and disposed of at an onsite or offsite disposal facility. Alternatively, soils and sediment can be treated to destroy or immobilize COCs. Soil and/or sediment removal is applicable to all COCs at RQL.

Contaminated soil and/or dry sediment removal is retained as an option to be further evaluated.

5.2.5 Treatment

Process options evaluated for soil/sediment treatment include various in situ and ex situ physical, chemical, biological, and thermal options.

5.2.5.1 <u>In Situ Physical/Chemical Treatment</u>

In situ physical and chemical treatment process options evaluated included chemical oxidation/reduction (Redox), electrokinetic separation, fracturing (enhancement), soil flushing, soil vapor extraction (SVE), and stabilization/solidification.

<u>Chemical Redox</u>: Chemical Redox processes involve the addition of appropriate chemicals to raise or lower the oxidation state of the reactant. Oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Non-

halogenated SVOCs are resistant to oxidation, and metals may form toxic byproducts or become mobilized. For these reasons, chemical Redox is not retained for further evaluation for RQL.

Electrokinetic Separation: Electrokinetic separation is a method by which a low-voltage direct current is applied across the contaminated soil area via ceramic electrodes. Positively charged organics and metal ions move toward the cathode and negatively charged ions move toward the anode. The charged contaminants move by either electromigration or electroosmosis. In electromigration, charged particles are transported through the substrate. In contrast, electroosmosis is the movement of a liquid containing ions relative to a stationary charged surface. Of the two, electromigration is the main mechanism for the electrokinetic separation process. The direction and rate of movement of an ionic species will depend on its charge, both in magnitude and polarity, as well as the magnitude of the electroosmosis-induced flow velocity. Non-ionic species, both inorganic and organic, will also be transported along with the electroosmosis induced water flow. The two common approaches to soil treatment are "enhanced removal" and "treatment without removal." Enhanced removal is achieved by electrokinetic transport of contaminants toward the polarized electrodes to concentrate the contaminants for subsequent removal and ex situ treatment. Treatment without removal involves the forced movement of the charged contaminants through in situ treatment zones. The polarity of the electrodes is periodically reversed to aid in soil treatment (FRTR 2005). The reliance of charged ions for effectiveness renders this process ineffective for treating explosives.

Electrokinetic separation is not retained for RQL as the COC would not be effectively treated via this option.

Fracturing (Enhancement): Fracturing is a remediation enhancement technique used to increase the efficiency of other in situ remediation technologies. Fracturing, as the name implies, involves the creation of horizontal and/or vertical fractures in the subsurface soil matrix to improve soil permeability. Typical methods used include (FRTR 2005):

- Blast-Enhanced Fracturing: Involves the use of controlled detonation of explosives in the subsurface.

- Hydraulic Fracturing: Involves the injection of pressurized water into the subsurface to initialize a fracture followed by an injection of slurry of water, sand and thick gel under high pressure to propagate the fracture.

- Pneumatic Fracturing: Involves the injection of highly pressurized air through injection wells to expand existing soil fractures and create new fractures.

- Lasagna™ Process: Combines hydraulic fracturing with electrokinetic separation via electroosmosis. Horizontal fractures are created in the subsurface soil matrix to enhance contaminant movement while in situ electrodes move contaminant ions through a treatment zone.

The FRTR ranks this treatment technology as average for nonhalogenated and halogenated SVOCs and is considered "worse" for inorganics. Conditions at RQL involve surficial soils and sediment that render the installation of horizontal and vertical fractures impractical and undesirable respectively. Therefore, fracturing is not retained for RQL.

Soil Flushing: Soil flushing is the application or injection of water into an area of contaminated soil to bring the water tables in contact with and promote leaching of soil contaminants. The dissolved contaminants then are extracted and treated. Cosolvent enhancement is a method by which solvents (i.e., acids, bases, or surfactants) are mixed with the water to enhance contaminant solubility and removal. Soil flushing is highly effective for treating metals, but ineffective for explosives (FRTR 2005). Conditions at RQL render implementation of in situ soil flushing problematic. Contaminated soils and sediment at RQL are surficial in nature and associated with drainage ditches and areas prone to flooding. Properly implementing and controlling the soil flushing process under these conditions would be difficult. Consequently, this process is not retained for further evaluation at RQL.

Soil Vapor Extraction: SVE is an in situ unsaturated (vadose) zone soil remediation technology in which a vacuum is applied to the soil to induce the controlled flow of air and remove volatile and some semivolatile contaminants from the soil. The gas leaving the soil may be treated to recover or destroy the contaminants, depending on local and state air discharge regulations. Vertical extraction vents are typically used at depths of 1.5 m (5 ft) or greater and have been successfully applied as deep as 91 m (300 ft). Horizontal extraction vents (installed in trenches or horizontal borings) can be used as warranted by contaminant zone geometry, drill rig access, or other AOC-specific factors. This process is only effective for VOCs and some SVOCs (FRTR 2005) and is not generally applicable to the COCs present at RQL. In addition, the surficial nature of impacted soils and sediment is not conducive to SVE techniques.

Stabilization/Solidification: Stabilization/solidification (S/S) immobilizes contaminants within a matrix by chemical fixation or vitrification. Chemical fixation is typically accomplished using an auger/caisson system to mix contaminated soils with chemical agents and/or cement additives. Fixation processes can result in a significant increase in total waste volume (i.e., up to a doubling of volume) and usually require leachate testing to ensure contaminant mobility has been sufficiently reduced. Vitrification processes immobilize inorganic contaminants while destroying organic pollutants by applying an electric current to melt soil and other earthen materials at temperatures on the order of 1600-2000°C. The resulting glass and crystalline mass is inert. Organic combustion products and water vapor are typically captured and treated through an off-gas treatment system. Vitrification is an immobilizing technology. Since organic compounds are generally not immobilized, it is generally considered ineffective for treating explosives.

The presence of contaminated surficial soil and sediment in potentially inundated areas at RQL renders the in situ application of S/S processes difficult. Therefore, this process is not retained for further consideration for RQL.

5.2.5.2 Ex Situ Physical/Chemical Treatment

Ex situ physical/chemical treatment options apply to contaminated soils which have first been removed by excavation (i.e., removal).

Chemical Extraction: Chemical extraction is the application of a chemical extractant to collect and concentrate contaminants from soil. The collected contaminants are then placed in a separator (e.g., centrifuge) to remove the solvent for disposal. Two types of chemical extraction are typically performed, acid extraction and solvent extraction.

Acid Extraction: Acid extraction uses hydrochloric acid to extract heavy metal contaminants from soils. In this process, soils are first screened to remove coarse solids. Hydrochloric acid is then introduced into the soil in the extraction unit. The residence time in the unit generally ranges between 10 and 40 min depending on the soil type, contaminants, and contaminant concentrations. The soil-extractant mixture is continuously pumped out of the mixing tank and separated using hydrocyclones. The separated soil is dewatered and mixed with an acid-neutralizing agent (e.g., lime) to neutralize any remaining acid. The acid solution is regenerated using a precipitant and flocculent to remove dissolved metals (FRTR 2005).

Solvent Extraction: Solvent extraction is accomplished with the use of an organic solvent. This process is often combined with other technologies such as stabilization, incineration, or soil washing, but can be used as a stand-alone technology in some instances. The solvent must be carefully selected since soils may contain residual solvent concentrations subsequent to treatment. Solvent extraction processes are highly effective in treating SVOCs and metals, but ineffective for explosives.

Chemical extraction is retained for further evaluation.

Chemical Redox: Ex situ chemical Redox is identical to the in situ process described in Section 5.2.5.1 with the exception that soils are removed for treatment. Potentially large amounts of chemical waste products would be generated through this option, requiring additional waste treatment and disposal. This process primarily has been proven effective for treating mobile inorganics such as cyanide and chromium. For these reasons, chemical Redox is not retained for further evaluation for RQL.

Dehalogenation: Dehalogenation uses various methods to remove a halogen molecule from organic chemicals within the soil. This method is only effective at treating halogenated VOCs and SVOCs, which are not present in large quantities at RQL. Therefore, it is eliminated from further evaluation.

Soil Washing: Soil washing achieves volume reduction of contaminated soils and sediments in two ways: by dissolving or suspending the contaminants in the wash solution or by concentrating the contaminants into a smaller volume through particle size separation. Soil washing systems that incorporate both techniques are generally the most effective. Soil washing involves pre-treating contaminated soils to remove larger objects, then washing the soils with water (with or without additives to improve contaminant extraction) to remove target constituents. Conventional soil washing systems are not typically effective for soils containing large amounts of clay and silt. Incorporating other physical and chemical processes can enhance the effectiveness of soil washing. During the soil washing operation, the majority of the process water is filtered and recycled back into the treatment system. A small volume of this water stream would require periodic discharge. Following treatment, the reduced soil fraction may be further treated (such as solidification) if required. The resulting "clean" soils could be placed back onsite or reused at another location.

Soil Washing: Soil washing is commonly applied to soils impacted with SVOCs, fuels, heavy metals and select VOCs and pesticides. This process has limited application experience in treating explosives. Soil washing is retained for further evaluation for RQL.

Stabilization/Solidification: Ex situ S/S immobilizes contaminants within excavated soils using chemical fixation and vitrification. These processes are described in detail in Section 5.2.5.1. These processes are highly effective for immobilizing inorganic contaminants, preventing exposures or migrations to exposure points. Treating explosives or SVOCs may be limited. S/S is retained for further evaluation at RQL.

5.2.5.3 Biological Treatment

Enhanced Bioremediation: Technologies involve destruction or transformation techniques in which favorable environments are created for microorganisms or plant systems to grow and use contaminants as a food or energy source. Processes include slurry-phase, solid phase, and anaerobic biodegradation. Biological treatment is generally most effective for treating organic contaminants. Bioremediation in soil is typically not applicable for treating inorganic contaminants (metals such as arsenic and manganese) and of limited effectiveness for PAHs and explosives. Consequently, enhanced bioremediation is not retained for further evaluation for RQL.

Monitored Natural Attenuation: Monitored Natural Attenuation (MNA) is a passive remedial measure that relies on natural processes to reduce the contaminant concentration over time. MNA is a viable remedial process option if it can reduce contamination within a reasonable time frame, given the particular circumstances of the AOC, and if it can result in the achievement of remediation objectives. Use of MNA as a component of a remedial alternative is appropriate along with the use of other measures, such as source control or containment measures. MNA, like enhanced bioremediation is generally of negligible to limited effectiveness for inorganic contaminants, PAHs, and explosives. Similarly, MNA is not retained for further evaluation for RQL.

5.2.5.4 Thermal Treatment

Thermal treatment uses high temperatures to volatilize, decompose, or oxidize the contaminants. Various forms of thermal treatment technology including incineration, pyrolysis, and low temperature thermal desorption as described below:

- Incineration: High temperatures are applied in the presence of oxygen to combust organic compounds, converting them to carbon dioxide and water.

- Pyrolysis: Organic compounds are decomposed by high heat in the absence of oxygen, resulting in gaseous compounds and fixed carbon ash.

- Thermal Desorption: Heat volatilizes water and organics, which are collected and passed through a vapor treatment system.

Thermal treatment processes are generally used for the treatment of organic compounds and would not be effective for treating inorganic compounds. These options are not retained for further evaluation due to the potential for hazardous by-products from metal contamination in the soils.

5.2.6 Disposal and Handling

Both onsite and offsite disposal options were considered for the disposal of contaminated soils. All the following technologies were retained for RQL. Handling options involved truck, railcar or barge alternatives to transport wastes.

5.2.6.1 Onsite Disposal

Onsite disposal of soils in an engineered structure has been retained for further consideration. Land encapsulation is a proven and well-demonstrated technology. A facility would be designed and constructed to contain all the excavated materials or residuals after treatment. An onsite, engineered structure has been determined to be potentially applicable although such a facility may not be practicable due to logistical issues.

5.2.6.2 Offsite Disposal

Among the offsite disposal options considered were a new facility at a location in Ohio, or an existing federal or commercially licensed facility. A new offsite disposal facility in Ohio could be designed to reduce potential exposure and minimize the migration of impacted material. A properly designed disposal facility is considered protective of public health. This option could be considered if land is made available or treatment significantly reduces waste volume. Therefore, a newly constructed offsite disposal facility has been determined to be potentially applicable and is retained for further consideration for RQL.

Existing federal or commercially licensed and permitted disposal facilities exist for the types of waste at RVAAP and are retained for further consideration. Offsite disposal at an existing site is retained for further evaluation.

5.2.6.3 Handling

Offsite disposal requires waste materials to be transported to the selected disposal facility. A number of transportation options exist including trucks, railcars, and barges. These modes of transportation could be used individually or in combination to haul waste materials from RVAAP to the disposal facility. The scenarios for transportation could include trucking to a rail loading facility, direct trucking to the disposal facility, or trucking to a barge loading facility. Railcar is not considered feasible as an operable spur not present at AOC. Similarly, barges are not retained as a sufficient navigable waterway is not located proximate to the AOC. Trucks have been used successfully for the types of waste that will be generated at RQL and will be retained for further consideration.

5.2.7 Process Options Retained from Initial Screening

The process options retained through the initial screening process are summarized in Table 5-2 below. These options are further evaluated (Section 5.3) to identify the best set of options from which to develop remedial alternatives for RQL.

Table 5-2. Summary of Process Options Retained from Initial Screening for Soils/Dry Sediments at RQL

Process Option
No Action
Land Use Controls and 5-year Reviews
Bulk Removal
Excavation
Ex Situ Physical/Chemical
Chemical Extraction
Soil Washing
Stabilization/Solidification
Disposal
Onsite Engineered Land Encapsulation
Offsite Newly Constructed Facility
Onsite Existing Facility
Handling
Truck

5.3 DETAILED SCREENING OF TECHNOLOGIES

The remedial action technologies retained from the initial screening process described in Section 5.2 were further evaluated against criteria of effectiveness, implementability, and cost (three of the NCP balancing criteria). The rationale for either retaining or eliminating options for each AOC is presented below and summarized in Table 5-2 (at the end of this chapter) for soils and dry sediments.

5.3.1 Criteria Used for Detailed Screening

Remedial action technologies retained from the initial screening process were further evaluated using three the criteria (effectiveness, implementability, and cost) to determine the most appropriate technologies for remediating RQL. The remedial options retained from detailed screening process were used in developing the remedial alternatives described in Chapter 6.

5.3.1.1 Effectiveness

The effectiveness criterion assesses the ability of a remedial technology to protect human health and the environment by reducing the toxicity, mobility, or volume of contaminants. Each technology was evaluated for the ability to achieve RAOs, potential impacts to human health and the environment during construction and implementation, and overall reliability of the technology.

5.3.1.2 Implementability

Each process option technology was evaluated for implementability in terms of technical feasibility, administrative feasibility, and availability of the necessary materials, equipment, and work force. The assessment considers each technology’s short- and long-term implementability. Short-term implementability considerations include constructability of the remedial technology, near term reliability, and the ability to obtain necessary approvals, with other agencies, and the likelihood of obtaining a favorable community response. Long-term implementability evaluates the ease of undertaking additional remedial actions if necessary, monitoring the effectiveness of the remedy, and operation and maintenance (O&M).

5.3.1.3 Cost

The cost criterion evaluates each remedial process in terms of relative capital and O&M costs. Costs for each technology are rated qualitatively, on the basis of engineering judgment, in terms of cost effectiveness. Therefore, a low cost remedial technology would be rated as highly cost effective, while a costly technology would be evaluated as being of low cost effectiveness.

5.3.2 No Action

The no action alternative provides a baseline for comparison with all other remedial alternatives and is required by CERCLA. This alternative provides no protection for human health and the environment. Any current access restrictions and monitoring programs would discontinue. No remedial actions would be taken to reduce, contain, or remove contaminated soils and no effort would be made to prevent or minimize human and environmental exposure to residual contaminants. Offsite migration of contaminants would not be mitigated under this alternative.

Potential effects on human health and the environment under this alternative are evaluated in the RI Report. The RI Report indicated human health risks for potential future land use at RQL are in exceedance of the acceptable cancer risk of 1E-06 and the HI is in exceedance of 1. Under the no action alternative, there would be no reduction in the mobility, volume, or toxicity of SRCs.

5.3.3 Land Use Controls and 5-year Reviews

Land use controls and 5-year reviews generally are not used as the sole remedy, but are integrated and supplement implementation of an engineering remedy. The protectiveness of a remedy utilizing land use controls can be enhanced by layering or employing mutually reinforcing land use controls.

Effectiveness: Land use controls are physical, legal, and administrative mechanisms designed to maintain the elements of a remedy and ensure its protectiveness. Land use controls would increase the protection of human health and the environment over baseline (i.e., no action) conditions by restricting or limiting AOC use.

Although there would be no reduction in volume, toxicity, or mobility of contaminants in media onsite, future risk could be maintained at acceptable levels provided durable land use controls could be implemented, maintained, and enforced. 5-year reviews (including the environmental monitoring program) should continue as long as the land use controls remain in effect to ensure appropriate controls continue to be implemented and maintained.

Implementability: Access restrictions are currently in place at RQL. The US Army has managed this land in the past under internal policies and future use of RQL will involve AOC transfer between two US Army organizations. These process options would be easily implemented.

Cost: Implementing land use controls are moderate to highly cost effective. Potential legal fees, compensation for implementing land use controls, administrative fees, and possible property purchases could decrease the cost effectiveness of this alternative. The high cost effectiveness rating would include only legal fees; the moderate rating would be the purchase of a real estate interest (e.g., a negative easement). Both high and moderate cost ratings include environmental monitoring to conduct 5-year reviews. Capital cost would be low but O&M costs could be significant. Environmental monitoring would include periodic sampling and is considered to be low capital and low O&M costs.

Land use controls and 5-year reviews are retained for inclusion in remedial alternatives for RQL.

5.3.4 Removal

Removal technologies protect human health and the environment by physically separating the impacted materials from potential receptors. The removal process option (i.e., excavation of soil and/or dry sediment) was retained for RQL for detailed screening.

Effectiveness: Soil/sediment removal is effective in protecting human health and the environment and reducing future residual risk. The potential for exposure to fugitive dust, contaminant leaching, and generation of contaminated surface water runoff would be greatly reduced with implementation of this option.

Implementability: Soil/sediment excavation is easily implemented using readily available resources and conventional earth-moving equipment. Some ancillary construction activities may be necessary such as temporary roads, a staging area for loading and unloading, soil erosion control, excavation dewatering, water treatment, dust control, and additional clearing and grubbing. Administrative coordination between remediation activities and OHARNG operations would need to be well planned to minimize impacts.

Cost: The cost effectiveness of soil and/or dry sediment removal is rated moderate to low. Capital costs related to soil removal are moderate. O&M costs would be low.

Removal technologies are retained for RQL.

5.3.5 Physical/Chemical Treatment

AOC-specific laboratory or pilot scale data are not currently available to assess the potential effectiveness of the physical treatment technologies. Published literature, previous experience at other sites, and vendor information were used to judge effectiveness, implementability, and cost.

5.3.5.1 Ex Situ Chemical Extraction and Soil Washing

Chemical extraction and soil washing are similar technologies which utilize a solvent to extract contaminants from soil/sediment media. Both technologies were initially screened to be applicable to RQL COCs, however, the quantities of expected soil volumes render this option unrealistic. Detailed screening results are described below.

Effectiveness: Chemical extraction and soil washing are proven effective technologies for numerous organic and inorganic contaminants. The treatment effectiveness for RVAAP COCs, particularly SVOCs and explosive constituents, is uncertain. Laboratory and conceptual design studies would need to be conducted on soils from RQL to assess treatment processes. Both chemical extraction and soil washing likely would produce waste streams requiring additional treatment and/or disposal.

Implementability: Chemical extraction or soil washing would be moderately difficult to implement onsite. Formulating a solvent mixture capable of treating RVAAP's COCs may be problematic. In addition, chemical extraction typically involves solvent recovery by conventional distillation. Heating solvent containing explosives may present safety issues. Alternatively, discharging solvent from chemical extraction or soil washing processes may require substantial pretreatment and approval processing from regulatory agencies.

Cost: Both chemical extraction and soil washing are moderate to low in terms of cost effectiveness. The small total volumes of contaminated soil/sediment and high start up costs for the treatment systems reduce the cost effectiveness of these technologies.

Chemical extraction and soil washing are not retained for RQL due to the questionable effectiveness of the technology, difficulty of implementation, and low potential cost effectiveness.

5.3.5.2 Ex Situ Stabilization/Solidification

Effectiveness: Ex situ S/S consists of chemical fixation or vitrification. S/S via chemical fixation is one of the oldest most established remediation technologies available. It has been successfully used to reduce the mobility of metal and organic-contaminants in waste. Treatment effectiveness generally is limited for SVOCs and explosives. Treatment of soils and sediments by S/S poses minimal risks to the local community and workers. Some dust may be generated during excavation; however, the amount generated would be equivalent to that generated with any remedial alternative requiring excavation and soil handling. Most chemical fixation processes result in a significant volume increases (up to double the original volume) and are typically most effective at treating metal-contaminated waste to meet disposal facility acceptance criteria.

Vitrification is typically used to address highly concentrated mobile contaminants, unlike those at RQL. Vitrification poses a much higher risk to onsite workers compared to other treatment operations due to the high temperatures and specialized equipment required. Verifying that all of the contaminated soils have been successfully vitrified can be difficult, since the resulting glass matrix acts as a barrier to sampling not only at the glass matrix-soil interface, but also within the glass matrix itself.

Implementability: Ex situ S/S via chemical fixation is easy to moderate to implement at RQL. Contaminated soils and dry sediment would require excavation and transport to a central staging area for onsite treatment. The S/S materials likely would be of greater volume than original waste amounts. The treated waste would then be manifested and sent offsite by a licensed transporter for disposal at a licensed disposal facility. Qualified vendors and equipment are readily available to perform this treatment operation.

Vitrification is moderate to difficult to implement. Vitrification has successfully treated organic and metal contaminants, but generally for much higher contaminants concentrations and smaller quantities of wastes. While some volume reduction occurs during melting, the total volume of the final waste material often increases due to the addition of glass formers. Qualified vendors and equipment are available to perform this treatment operation.

Cost: The cost effectiveness of chemical fixation technologies for RQL is moderate. Disposal costs may be significantly increased due to the larger waste volumes requiring disposal. Vitrification is low in terms of cost effectiveness with high capital costs for implementation.

Ex situ S/S via chemical fixation and vitrification are not retained for RQL due to the uncertainties associated with confirmation sampling, high cost for the expected low removal volumes, and potential dangers to onsite workers during implementation.

5.3.6 Disposal and Handling

Initial screening results indicated three disposal options and one handling are potentially applicable to RQL. Detailed screening evaluations for these remedial technologies are presented below.

5.3.6.1 Onsite Disposal at a New Engineered Structure

This option involves the design and construction of a new disposal facility onsite.

Effectiveness: Onsite disposal at a new engineered structure would be effective for physically separating impacted materials from potential receptors. Effectiveness concerns for onsite disposal include the ability of the AOC to meet engineering design criteria (i.e., geologic conditions, foundation soils, groundwater, seismic activity) for the siting and licensing of a disposal cell in the state of Ohio.

Implementability: The design and construction of a new disposal facility onsite would be difficult. Siting studies, facility design, environmental assessments and/or environmental impact statements, and public review would be required prior to implementation of this option. The public may have concerns regarding a new onsite disposal facility if adequate disposal capacity existed elsewhere. These requirements could result in unacceptable delays. During the selection process, activities related to the construction and operation of the facility would be analyzed, and studies would be required to eliminate or minimize unacceptable impacts. The State of Ohio siting and licensing process also would render this alternative technology difficult to implement administratively. This option will also introduce long term surveillance, monitoring, and maintenance requirements.

Cost: A new onsite disposal cell would be low in terms of cost effectiveness. Capital costs would be substantial and be accompanied by moderate to high O&M costs for maintenance. There would be no disposal fees associated with a dedicated onsite facility.

The design and construction of a new disposal facility onsite is not retained for RQL. The difficulty in implementing this option combined with low cost effectiveness render this option undesirable.

5.3.6.2 Offsite Disposal at a New Engineered Structure

This option involves the design and construction of a new offsite disposal facility.

Effectiveness: The design and construction of a new offsite disposal facility would be effective in protecting human health and the environment by physically separating impacted materials from potential receptors.

Implementability: Establishing a new disposal facility offsite would be similarly difficult as the design and construction of an onsite structure. The new offsite facility would face the technical requirements and potential public concerns as described in Section 5.3.6.3.

Cost: The cost effectiveness of a new offsite disposal cell would be low. Capital costs would be high with moderate to high O&M costs. There would be no disposal fees associated with a dedicated offsite facility

The design and construction of a new disposal facility offsite is not retained for RQL. This option is difficult to implement and has a low cost of effectiveness, thereby making this option undesirable.

5.3.6.3 Offsite Disposal at an Existing Facility

This option involves the utilization of an existing disposal facility to manage wastes.

Effectiveness: The use of an existing disposal facility would be effective in protecting human health and the environment. Many licensed and permitted facilities can accept waste streams similar to those anticipated to be generated at RVAAP. These facilities are very effective at isolating the material so as to prevent its impacting human health or the environment. By removing, but not treating contaminated soil, no reduction in toxicity, mobility, or volume is achieved. However, future risk is reduced by removing this material from the RVAAP. Offsite disposal options would be effective in terms of containing wastes generated by the RVAAP remediation and separating impacted materials from potential receptors.

Implementability: Using an existing facility to dispose of waste would be easy to implement based on previous disposal activities conducted at RVAAP. Additional contracts would need to be negotiated if impacted material is to be sent to a facility not currently contracted. A number of properly permitted facilities are available in the United States that could serve as locations for disposal of some or all of the potential waste streams. Additionally, a number of licensed transporters should be available to haul properly documented waste.

Since several facilities may be contracted to receive different waste streams, a mechanism would need to be in place to ensure that the waste was properly segregated and that the regulatory agencies are satisfied with the procedures.

Cost: The cost effectiveness of utilizing a licensed and permitted disposal facility is rated to be moderate. There would be no long-term O&M costs since soil contaminated above cleanup goals would be removed from the AOC.

Offsite disposal at an existing facility is retained for RQL.

5.3.7 Handling

Effectiveness: The transportation options for hauling contaminated soils involve the individual use of trucks for shipment from the AOC to the selected disposal facility. Trucks have been used extensively at other sites and are very effective due to their adaptability to AOC and route conditions. Trucks become less effective with greater haul distances due to safety concerns.

Implementability: The use of trucks is commonly implemented for transporting contaminated soils. Truck transportation uses readily available resources and conventional transportation equipment. Waste would be manifested or a bill-of-lading secured with all supporting documentation and a licensed transporter secured.

Cost: The cost effectiveness of transporting wastes by truck is moderate to low, depending on hauling distance.

Truck transportation is retained for RQL.

5.4 RETAINED PROCESS OPTIONS FOR SOILS/DRY SEDIMENTS

Table 5-4 summarizes the process options retained through the detailed screening process (Sections 5.2 and 5.3) for impacted soils/dry sediments at RQL.

Table 5-4. Retained Process Options for Soils and Dry Sediment at RQL

General Response Action	Technology Type	Process Option
Land Use Controls and 5-Year Reviews	Controls	Government, Enforcement, Informational, Legal Mechanisms, Physical Mechanisms
		Physical barriers, permanent markers, security personnel
	Environmental Monitoring	Groundwater, Surface Water
Removal	Bulk Removal	Excavation (Soil and Sediment)
Disposal and Handling	Offsite (Soil/Sediment)	Existing Facility
		Trucks

These options were used individually or in combination in the development of remedial alternatives described in Chapter 6 of this FS to address COCs in soils and dry sediments at RQL.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediment at RQL

General Response Action	Technology Type	Process Options	Description	Screening Comments
No Action	None	None	Current land use controls, access restrictions, and monitoring programs will be discontinued. No remedial technologies implemented to reduce hazards to potential human or ecological receptors.	Required to be carried through CERCLA analysis.
Land Use Controls and 5-Year Reviews	Controls	Government Controls	The managing authority could include a Facility Master Plan and installation-specific regulations to manage property and enforce management strategies.	Potentially applicable. May limit future land use options, depending on alternative selected and amount of contamination remaining.
		Enforcement Tools	Administrative orders and consent decrees available under CERCLA, can prohibit certain land uses by a party or require proprietary controls be put in place.	
		Informational Devices	Registries or advisories put in place to provide information that residual or capped contamination is onsite	
		Legal Mechanisms	Easements, deed restrictions, etc. placed on a property as part of a contractual mechanism	
		Physical Mechanisms	Fences, berms, warning signs, and security personnel put in place to prevent contact with contaminated media	
	Environmental Monitoring	Groundwater	Periodic monitoring of groundwater to ensure that contaminant migration from soils to groundwater is not occurring.	Potentially applicable. Required with alternatives where contamination remains above levels suitable for residential land use.
		Surface Water	Periodic monitoring of surface water to ensure contaminant migration from soils to surface water is not occurring.	Potentially applicable. Required with alternatives where contamination remains above levels suitable for residential land use.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Containment	Capping (Soil/ Sediment)	Native Soil/Sediment	Uses native soils or sediment to cover contamination and reduce migration by wind and water erosion.	Not applicable. AOC subject to periodic flooding. Installation and maintenance of containment system impractical.
		Clay	Installation of clay cap to limit water infiltration. Susceptible to weathering effects (e.g. cracking)	
		Synthetic Liner	Synthetic materials used to limit water infiltration, not as susceptible to cracking as clay.	
		Multi-Layered	Multiple layers of different soil types used to limit water infiltration, not as susceptible to cracking as clay	
		Asphalt/Concrete	Limits water infiltration, susceptible to cracking if not properly maintained.	
Removal	Bulk Removal	Excavation (Soil and Sediment)	Mechanically or hydraulically operated units such as excavators, front-end loaders, and bulldozers, and/or hand tools are used for trenching and other subsurface excavation.	Potentially applicable.
Treatment	In Situ Physical/ Chemical (Soil/ Sediment)	Chemical Redox	Addition of chemicals to raise or lower oxidation state of contaminants, chemically converting materials to less hazardous or non-toxic	Not applicable. Limited to negligible effectiveness for RQL COCs.
		Electrokinetic Separation	Low voltage current applied to media by ceramic electrodes. Positively and negatively charged metal and organic ions migrate to opposite electrodes	Not applicable. Not effective for RQL COCs.
		Fracturing	Creation through various methods of horizontal or vertical cracks in the media to enhance use of other remedial techniques	Not applicable. COCs associated with surficial soil. Impractical to install horizontal fractures. Vertical fractures counter productive.
		Soil Flushing	Injection of water (with or without co-solvents) to promote leaching of contaminants	Not applicable. RQL AOC conditions (i.e., contaminated surficial soil and periodic flooding of AOC) render in situ flushing impractical.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Treatment (continued)	In Situ Physical/ Chemical (Soil/ Sediment) (continued)	Soil Vapor Extraction	Vacuum is applied to soil to control air movement and extract volatile contaminants in gaseous form	Not applicable. Limited effectiveness for RQL COCs. AOC conditions (i.e., contaminated surficial soil and periodic flooding of AOC) render soil vapor extraction impractical.
		Stabilization/Solidification	Immobilizes contaminants in the matrix in which they are found, using various techniques such as cement injection or vitrification	Not applicable. RQL AOC conditions (i.e., periodic flooding of AOC) render in situ stabilization / solidification impractical.
	Ex Situ Physical/ Chemical (Soil/ Sediment)	Chemical Extraction	Acids or solvents are applied to soils to remove contaminants, then passed through a separator to remove contaminants from the extraction	Potentially applicable.
		Chemical Redox	See above (In Situ Chemical Redox)	Not applicable. Not effective for RQL COCs.
		Dehalogenation	Uses various methods to remove a halogen molecule from organics, reducing toxicity	Not applicable. Not effective for RQL COCs.
		Separation	Physically sort soils to remove contaminated from uncontaminated portions.	Not applicable. Not effective for RQL COCs.
		Soil Washing	Reduces contaminated media volume by dissolving or suspending contaminants, or physically separating uncontaminated portions from contaminated portions	Potentially applicable.
		Stabilization/Solidification	See above (In Situ Stabilization/Solidification)	Potentially applicable. Limited effectiveness for high levels of SVOCs.

Table 5-1. Initial Screening of Technology Types and Process Options for Soils/Dry Sediment (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Treatment (continued)	Biological (Soil/ Sediment)	Bioremediation	A favorable environment is created for microbe, fungus, or plant systems to utilize and breakdown contaminants	Not applicable. Not effective for RQL COCs and AOC conditions.
		MNA	Passive remedial measure relies on natural processes to reduce contaminant concentration.	
	Ex Situ Thermal Treatment (Soil/ Sediment)	Incineration	High temperatures are applied to combust (in the presence of oxygen) organic contaminants	Not applicable. Not effective for RQL COC.
		Pyrolysis	Organic compounds are decomposed by applying heat in the absence of oxygen, resulting in gaseous components and a solid residue of fixed-carbon ash	Not applicable. Not effective for RQL COC.
		Thermal Desorption	Heat is applied to volatilize water and organics, which are carried to a gas treatment system	Not applicable. Not effective for RQL COC.
Disposal and Handling	Onsite (Soil/ Sediment)	Engineered Land Encapsulation	An onsite facility is constructed to house contaminated media, preventing contaminant migration	Potentially applicable.
	Offsite (Soil/ Sediment)	Newly Constructed Facility	A newly constructed offsite facility designed specifically to house the contaminated media being removed from the AOC	Potentially applicable.
		Existing Facility	An existing disposal facility that meets the requirements to house contaminated media from the AOC.	Potentially applicable.
	Handling	Truck	Transportation of wastes from the AOC to the disposal facility	Potentially applicable.
		Railcar		Not applicable. No operable rail spur located proximate to AOC.
		Barge		Not applicable. No sufficient navigable waterway located proximate to AOC.

AOC = Area of concern.
COC = Constituent of concern.
MNA = Monitored natural attenuation.
RQL = Ramsdell Quarry Landfill.
SVOC = Semivolatile organic compound.

Table 5-3. Detailed Screening of Technology Types and Process Options for Soils/Dry Sediment

General Response Action	Technology Type	Process Options	Detailed Screening Criteria: Effectiveness	Detailed Screening Criteria: Implementability	Detailed Screening Criteria: Cost	Screening Results
No Action	None	None	Not effective. Required to be carried through the CERCLA analysis.	Easy	Highly cost effective. No costs associated with implementation.	Retained
Land Use Controls and Monitoring	Controls	Government, Enforcement, Informational, Legal Mechanisms, Physical Mechanisms	Effective for mid to long term. Information devices effective for short-term	Easy to moderate. Legal mechanisms may be easy to difficult to implement.	Moderate to high cost effectiveness	Retained
		Physical barriers, permanent markers, security personnel	Short-term effectiveness in reducing exposure.	Easy	Moderate to high cost effectiveness	Retained
	Environmental Monitoring	Groundwater and Surface Water	Documents AOC conditions. Does not reduce risk but will act as a preventative measure by providing information concerning changes in conditions.	Easy	Moderate to high cost effective	Retained
Removal	Bulk Removal	Excavation (Soil and Sediment)	Effective. Removes source of risk from RQL.	Easy	Moderate to low cost effectiveness	Retained
Treatment	Ex Situ Physical/Chemical (Soil/Sediment)	Chemical Extraction	Treatment effectiveness for RQL COCs uncertain pending treatability studies. Will produce waste streams requiring additional treatment or disposal.	Moderately difficult	Moderate to low cost effectiveness. Small soil volumes and treatment systems high start up cost reduce cost effectiveness of system.	Not Retained
		Soil Washing				
		Stabilization/Solidification	Generally limited effectiveness in treating high levels of SVOCs. A treatability study will be required to determine effectiveness for RQL COC. May result in net increases in waste volumes.	Easy to moderate		Retained

Table 5-3. Detailed Screening of Technology Types and Process Options for Soils/Dry Sediment (continued)

General Response Action	Technology Type	Process Options	Detailed Screening Criteria			Screening Results
			Effectiveness	Implementability	Cost	
Disposal and Handling	Onsite (Soil/Sediment)	Engineered Land Encapsulation	Effective at physically separating contaminants from possible receptors	Difficult	Low cost effectiveness	Not Retained
	Offsite (Soil/Sediment)	Newly Constructed Facility	Effective at physically separating contaminants from possible receptors	Difficult	Low cost effectiveness	Not Retained
		Existing Facility	Effective at physically separating contaminants from possible receptors	Easy	Moderate cost effectiveness	Not Retained
	Handling	Trucks	Effective	Easy	Moderate to low effectiveness, depending on distance	Retained

AOC = Area of concern.
COC = Constituent of concern.
MNA = Monitored natural attenuation.
RQL = Ramsdell Quarry Landfill.
SVOC = Semivolatile organic compound.

6.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

This chapter describes the remedial alternatives assembled for impacted soils /dry sediments at RQL. The remedial alternatives were constructed by combining general response actions, technology types, and process options retained from the screening processes described in the previous chapter. Remedial alternatives should assure adequate protection of human health and the environment, achieve RAOs, meet ARARs, and permanently and significantly reduce the volume, toxicity, and/or mobility of COCs.

The remedial alternatives presented herein address impacted soils/ dry sediments at RQL (Section 3.6). The remedial alternatives encompass a range of potential remedial actions as listed below:

- Alternative 1: No Action;
- Alternative 2: Limited Action;
- Alternative 3: Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker Land Use; and
- Alternative 4: Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use.

Alternative 1 is the no action response required under the NCP. Alternative 2 relies on land use controls. No source control or removal actions are implemented under Alternative 2. Alternatives 3 and 4 address organic and inorganic impacts and utilize monitoring in combination with removal technologies (i.e., excavation). These two alternatives also involve excavating impacted soils/dry sediments and disposal at an offsite facility.

Time periods for environmental monitoring were developed dependent on relevant ARARs and the specific technologies employed under each remedial alternative. For the no action alternative, the assumed time period is zero. For Alternatives 2 and 3, environmental monitoring was assumed to be conducted for 30 years.

6.1 ALTERNATIVE 1: NO ACTION

Under Alternative 1, current access restrictions and monitoring programs at RQL will discontinue and no additional actions regarding access or land use controls will be implemented. Alternative 1 provides no additional protection to human health and the environment under current conditions. This remedial alternative is required under the NCP as a no action baseline against which other remedial alternatives can be compared.

Since soils/dry sediments will remain under Alternative 1, any impacts to groundwater also would continue. Any current legal and administrative mechanisms and physical mechanisms (e.g., RVAAP perimeter fence) would be discontinued. Environmental monitoring would not be performed. In addition, no restrictions on land use would be pursued.

6.2 ALTERNATIVE 2: LIMITED ACTION

For Alternative 2, land use controls would be implemented for RQL with the exception of the landfill. The landfill currently has access restrictions and monitoring performed as part of the closure. Land use controls or AOC restrictions proposed in any RD addressing chemical contamination of soils/dry sediments at RQL will not supersede existing requirements for the landfill. Additionally, land use controls may be required due to potential MEC issues; these would be developed and implemented by the US Army and OHARNG under the auspices of the MMRP.

Alternative 2 relies on land use controls to limit exposures to COCs in soils/dry sediments. Impacted media would be left in place with no active remedial measures implemented. Utilization of RQL is assumed to correspond to OHARNG established future land use. Long-term management would be implemented. Prior to implementation of Alternative 2, an RD detailing 5-year review requirements, continuation of current environmental monitoring for the closed landfill, and any supplemental access restrictions to address chemical contamination of soil would be developed.

An RD would be developed to address maintenance activities, monitoring requirements (such as 5-year reviews), and land use controls. The RD would incorporate existing access restrictions. A more detailed discussion of the land use controls would be developed as part of the RD including notification requirements for changes in land use. Coordination with any planned OHARNG AOC improvement and environmental monitoring activities would be necessary to ensure consistency with RQL's designated land use and RAO. Pursuant to CERCLA, a review would be conducted every five years, as COCs would remain onsite above unrestricted (i.e., residential) land use preliminary cleanup goals. 5-year reviews permit evaluation of all remedy components including land use controls to assess the presence and behavior of remaining COCs. Continued surveillance would ensure any land use changes or disturbances of impacted areas are identified.

6.3 ALTERNATIVE 3: EXCAVATION OF SOILS/DRY SEDIMENTS AND OFFSITE DISPOSAL ~ SECURITY GUARD/MAINTENANCE WORKER LAND USE

Alternative 3 consists of excavating impacted soils/dry sediments to meet the preliminary cleanup goals for the Security Guard/Maintenance Worker. Excavated soils/dry sediments would be subsequently disposed of offsite at the licensed disposal facility. Utilization of the AOC is assumed to correspond to OHARNG established future land use for RQL. Alternative 3 will require coordination of remediation and monitoring activities with OHARNG and the US Army. Such coordination will minimize health and safety risks to onsite personnel and potential disruptions during remediation activities. The amount of time to complete this remedial action is relatively short and includes an O&M period (30 years is the assumed duration for cost estimating purposes). Components of this remedial alternative include:

- Remedial Design Plan;
- Excavation;
- Handling of waste materials;
- Offsite disposal;

- Confirmatory sampling;
- Restoration;
- Land use controls; and
- 5-year reviews.

Remedial Design Plan. An RD plan would be developed prior to the initiation of remedial actions. This plan would detail AOC preparation activities, the extent of the excavation, implementation, sequence of construction activities, decontamination, and segregation, transportation, and disposal of various waste streams. Engineering and administrative controls (e.g., erosion controls, health and safety controls) will be developed during the active construction period to ensure remedial workers and the environment are protected.

Excavation. Impacted soils/dry sediments above the Security Guard/Maintenance Worker land use preliminary cleanup goals would be excavated and transported to a staging area for loading trucks. The extent of impacted soils/dry sediments at RQL is depicted in Figure 3B-1 (Appendix 3B). This extent assumes confirmatory MI sampling will not result in further soil/dry sediment removal. Total disposal volume (i.e., ex situ) is estimated to be 423 yd^3. Impacted soils/dry sediments removal would be accomplished using standard construction equipment such as excavators, bulldozers, front-end loaders, and scrapers. Excavation would be guided using a limited quantity of analytical samples. Oversize debris would be crushed or otherwise processed to meet disposal facility requirements. Movement of impacted soils/dry sediments would be performed using dump trucks and conventional construction equipment. Erosion control materials such as silt fences and straw bales would be installed to minimize erosion. Impacted soils/dry sediments would be kept moist or covered with tarps to minimize dust generation. Excavation would take place in stages to limit impacts to current AOC activities. The safety of remediation workers, onsite employees, and the general public would be covered in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Handling. Impacted soils/dry sediments would be hauled to a licensed and permitted disposal facility by truck. Trucks would be lined with polyethylene sheeting and covered with specially designed tarps or hard covers to prevent release of impacted soils/dry sediments. All trucks would be inspected prior to use and surveyed for contamination prior to leaving the AOC. Appropriate bills-of-lading [in accordance with the U. S. Department of Transportation (DOT) regulations for shipment of impacted materials on public roads] would accompany waste shipments. Only regulated and licensed transporters and vehicles would be used. All trucks will travel pre-designated routes and an emergency response plan will be developed in the event of a vehicle accident.

Transportation activities would be performed in accordance with an AOC-specific Transportation and Emergency Response Plan (TERP) developed in the RD plan. The TERP would evaluate the types and number of vehicles to be used; the safest transportation routes including considerations to minimize use of high traffic roads, public facilities, or secondary roads not designed for trucks; and emergency response procedures for responding to a vehicle accident.

Offsite Disposal. Impacted soils/dry sediments would be disposed of at an existing facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the types of wastes, location, transportation options, and cost. Waste streams with different constituents and/or characteristics may be generated. Disposal cost savings may be possible by utilizing specific disposal facilities for different waste streams.

Confirmatory Sampling. Confirmatory sampling would be conducted after excavation of each hotspot area. This sampling would confirm the National Guard Trainee land use preliminary cleanup goals have been achieved. Additionally, MI confirmation sampling would be conducted for soil/dry sediments in the entire RQL quarry bottom. These additional MI confirmation samples will be collected to re-assess the MI sampling performed during the 2003 Phase I RI field investigation. The MI samples collected during the 2003 Phase I RI were intended to evaluate the feasibility of sampling method instead of quantitative evaluation of contaminant nature and extent. Results from four of the 2003 MI samples indicated benzo(a)pyrene above the preliminary cleanup goal of 1.3 mg/kg. The SVOC laboratory reporting limits for the 2003 MI samples were set about 4 mg/kg because of the intended use of the data at the time, which is substantially higher than the preliminary cleanup goals for these chemicals. All of the 2003 results greater than preliminary cleanup goals were estimated values less than the reporting limit. Laboratory analyses for the planned MI confirmation samples will have lower reporting limits more suitable for comparison to the preliminary cleanup goals. The areas in which MI samples are collected will be surveyed with a portable Global Position System to define areas considered dry or underwater.

If confirmation sampling shows concentrations that exceed preliminary cleanup goals, either additional land use controls will be implemented or further soil/dry sediment removal will be required. Areas successfully remediated would be available for appropriate restricted land use only.

Restoration. Excavated areas that have attained the preliminary cleanup goals will be backfilled with clean soil (un-impacted soil excavated from the AOC and offsite fill) and re-vegetated. Fill would be tested prior to placement to ensure compliance with acceptance criteria established in the remedial design plan.

Land Use Controls. Land use controls would be implemented to restrict land use because soils/dry sediments would remain onsite above residential land use preliminary cleanup goals. The controls would be utilized to assure and reinforce protectiveness to human health.

5-year reviews. 5-year reviews and environmental monitoring would be conducted to assess potential offsite contaminant migration. Pursuant to CERCLA, a review would be conducted every five years since COCs would remain onsite above unrestricted (i.e., residential) land use preliminary cleanup goals.

6.4 ALTERNATIVE 4: EXCAVATION OF SOILS/DRY SEDIMENTS AND OFFSITE DISPOSAL ~ RESIDENT SUBSISTENCE FARMER LAND USE

Alternative 4 consists of excavating impacted soils/dry sediment to meet the preliminary cleanup goals for the Resident Subsistence Farmer. The area which exceeds the preliminary cleanup goals has shallow bedrock. Excavated soils/dry sediments would be subsequently disposed of offsite at the licensed disposal facility. Achieving the residential land use applies only to chemical contamination in soils/dry sediments. The soils media will not be unrestricted until MEC issues at the AOC are addressed under the MMRP. This remedial alternative also would require coordination of remediation and monitoring activities with OHARNG and the US Army to minimize health and safety risks to onsite personnel and disruption of their activities. The time period to complete this remedial action is relatively short and would not include an O&M period to assess impacts from soils/dry sediments. Reviews and sampling may be doen at RQL under facility-wide programs or as part of the MMRP. Components of this remedial alternative include:

- RD Plan;
- Excavation;
- Handling of waste materials;
- Offsite disposal;
- Confirmatory sampling; and
- Restoration.

Remedial Design Plan. An RD plan would be developed prior to the initiation of remedial actions. This plan would detail preparation activities, the extent of the excavation, implementation and sequence of construction activities, decontamination, and segregation, transportation, and disposal of various waste streams. Short-term land use controls will be necessary during the active construction period to ensure a safe remediation. Environmental monitoring would be conducted to confirm no impacts to groundwater from COCs in soils/dry sediments.

Excavation. Impacted soils/dry sediments above the Resident Subsistence Farmer land use preliminary cleanup goals would be excavated and transported to a staging area for loading into trucks. The extent of impacted soils/dry sediments at RQL above Resident Subsistence Farmer land use preliminary cleanup goals are depicted in Figure 3B-2 (Appendix 3B). This extent assumes confirmatory MI sampling will not result in further soil/dry sediment removal. Total disposal volumes (i.e., ex situ) are estimated to be 815 yd^3 for RQL. Standard construction equipment such as excavators, bulldozers, front-end loaders, and scrapers would be used to remove impacted material. Excavation would be guided using a limited quantity of analytical samples. Oversize debris would be crushed or otherwise processed to meet disposal facility requirements. Movement of impacted soils/dry sediments would be performed using dump trucks and conventional construction equipment. Erosion control materials such as silt fences and straw bales would be installed to minimize erosion. Impacted soils/dry sediments would be kept moist or covered with tarps to minimize dust generation. Excavating would be phased to limit impacts to current production activities. The safety of remediation workers, onsite employees, and the general public would be addressed in a site-specific health and safety plan. The health and safety plan would address potential exposures and monitoring requirements to ensure protection.

Handling. Impacted soils/dry sediments would be hauled to a licensed and permitted disposal facility by truck. Trucks would be lined with polyethylene sheeting and covered with specially designed tarps or hard covers to prevent release of impacted soils/dry sediments. All trucks would be inspected prior to use and surveyed for contamination prior to leaving the AOC. The appropriate bill-of-lading (in accordance with DOT regulations for shipment of impacted materials on public roads) would accompany the waste shipment. Only regulated and licensed transporters and vehicles would be used. The transport vehicles will travel pre-designated routes with an emergency response plan developed to address potential vehicle accident.

Transportation activities would be performed in accordance with a AOC-specific TERP developed in the RD plan. The TERP would evaluate the types and number of vehicles to be used; the safest transportation routes including considerations to minimize use of high traffic roads, public facilities, or secondary roads not designed for trucks; and emergency response procedures for responding to a vehicle accident.

Offsite Disposal. Impacted soils/dry sediments would be disposed of at an existing facility licensed and permitted to accept the characterized waste stream. The selection of an appropriate facility will consider the types of wastes, location, transportation options, and cost. Cost savings may be realized by utilizing specific disposal facilities for different waste streams.

Confirmatory Sampling. Confirmatory sampling would be conducted after excavation of each hotspot area. The sampling would confirm Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Additionally, MI confirmation sampling would be conducted for soil/dry sediments in the entire RQL quarry bottom. These additional MI confirmation samples will be collected to re-assess the MI sampling performed during the 2003 Phase I RI field investigation. The MI samples collected during the 2003 Phase I RI were intended to evaluate the feasibility of sampling method instead of quantitative evaluation of contaminant nature and extent. Results from four of the 2003 MI samples indicated benzo(a)pyrene above the preliminary cleanup goals of 0.59 mg/kg (adult) and 0.97 mg/kg (child). The SVOC laboratory reporting limits for the 2003 MI samples were set about 4 mg/kg because of the intended use of the data at the time, which is substantially higher than the preliminary cleanup goals for these chemicals. All of the 2003 results greater than preliminary cleanup goals were estimated values less than the reporting limit. Laboratory analyses for the planned MI confirmation samples will have lower reporting limits more suitable for comparison to the preliminary cleanup goals. The areas in which MI samples are collected will be surveyed with a portable Global Position System to define areas considered dry or underwater.

If confirmation sampling shows concentrations that exceed preliminary cleanup goals, either additional land use controls will be implemented or further soil/dry sediment removal will be required. Areas successfully remediated would be free for residential land use.

Restoration. Excavated areas that have attained Resident Subsistence Farmer land use preliminary cleanup goals will be backfilled with clean soil (un-impacted soil excavated from the AOC and offsite fill) and re-vegetated. Fill would be tested prior to placement to ensure compliance with acceptance criteria established in the design work plan.

Table 6-1. Summary of Remedial Alternatives

Alternative 1 – No Action This remedial alternative provides no further remedial action and is included as a baseline for comparison with other remedial alternatives. Access restrictions and environmental monitoring would be discontinued. The AOC will no longer have legal, physical, or administrative mechanisms to restrict AOC access. Additional actions regarding monitoring or access restrictions will not be implemented. 5-year reviews would not be conducted in accordance with CERCLA 121(c).
Alternative 2 – Limited Action This remedial alternative involves the implementation of land use controls and periodic monitoring (i.e., 5-year reviews) to detect any changes in the nature or extent of contamination at the AOC. Land use controls (e.g., administrative access and land use restrictions; warning and informational signs, no use of groundwater) would be developed and implemented by the US Army and OHARNG. Current land use controls with respect to maintenance of the closed landfill would continue to be implemented by the US Army. 5-year reviews would be conducted in accordance with CERCLA 121(c) to ensure the remedy remains protective.
Alternative 3 – Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soils/dry sediments above Security Guard/Maintenance Worker land use preliminary cleanup goals for offsite disposal. Impacted soils/dry sediments would be excavated and transported to an offsite disposal facility licensed and permitted to accept these wastes. Confirmation sampling would be conducted to 1) ensure Security Guard/Maintenance Worker land use preliminary cleanup goals have been achieved at hotspot removal areas and 2) verify the remaining soil/dry sediment in other areas of the quarry bottom does not exceed preliminary cleanup goals. Areas successfully remediated would be backfilled with clean soils, if appropriate. In addition to closure requirements for the landfill, land use controls may include continuing existing access restrictions; prohibiting changes in land uses; and conducting periodic inspection of the AOC to determine land use changes. Periodic environmental monitoring (i.e., groundwater) would be conducted to confirm no impacts to groundwater. The remedial action includes an O&M period. 5-year reviews would be conducted in accordance with CERCLA 121(c).
Alternative 4 – Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soil/dry sediment above Resident Subsistence Farmer land use preliminary cleanup goals for offsite disposal. Impacted soils/dry sediments would be excavated and transported to an offsite disposal facility licensed and permitted to accept these wastes. Confirmation sampling would be conducted to 1) ensure Resident Subsistence Farmer land use preliminary cleanup goals have been achieved at hotspot removal areas and 2) verify the remaining soil/dry sediment in other areas of the quarry bottom does not exceed preliminary cleanup goals. Areas successfully remediated would be backfilled with clean soils, as appropriate. Periodic environmental monitoring (i.e., surface water and groundwater) would be conducted under the facility-wide monitoring programs. Alternative 4 does not include O&M as residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative. Sampling and access restrictions may be required because of the existing closed landfill.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
O&M = Operations and maintenance.
OHARNG = Ohio Army National Guard.
AOC = Area of concern.

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7.0 ANALYSIS OF REMEDIAL ALTERNATIVES

7.1 INTRODUCTION

This chapter presents a detailed analysis of the four remedial alternatives that have been formulated for further evaluation. From this set of alternatives, one or more will ultimately be chosen as the remedy for contaminated soils and/or dry sediments at RQL. Under the CERCLA remedy selection process, the preferred remedial alternative is suggested in the PP and set forth in final form in the ROD. A detailed evaluation of each alternative is performed in this chapter to provide the basis and rationale for identifying a preferred remedy and preparing the PP.

To ensure the FS analysis provides information of sufficient quality and quantity to justify the selection of a remedy, it is helpful to understand the requirements of the remedy selection process. This process is driven by the requirements set forth in CERCLA Section 121. In accordance with these requirements (USEPA 1988), remedial actions must:

- Be protective of human health and the environment;
- Attain ARARs;
- Be cost effective;
- Use permanent solutions and alternative treatment technologies to the maximum extent practicable; and
- Satisfy the preference for treatment that, as a principle element, reduces volume, toxicity, or mobility.

CERCLA emphasizes long-term effectiveness and related considerations for each remedial alternative. These statutory considerations include:

- Long-term uncertainties associated with land disposal;
- The goals, objectives, and requirements of the Solid Waste Disposal Act;
- The persistence, toxicity, and mobility of hazardous substances, and their propensity to bio-accumulate;
- Short- and long-term potential for adverse health effects from human exposure;
- Long-term maintenance costs;

- The potential for future remedial action costs if the remedial alternative in question was to fail; and

- The potential threat to human health and the environment associated with excavation, transportation, and re-disposal, or containment.

These statutory requirements are implemented through the use of nine evaluation criteria presented in the NCP. These nine criteria are grouped into threshold criteria, balancing criteria, and modifying criteria, as described below. A detailed analysis of each alternative against the evaluation criteria is contained in the following sections. The detailed analysis includes further definition of each alternative, if necessary, compares the alternatives against one another and presents considerations common to alternatives.

7.1.1 Threshold Criteria

Two of the NCP evaluation criteria relate directly to statutory findings that must be made in the ROD. These criteria are thus considered to be threshold criteria that must be met by any remedy to be selected. The criteria are:

1. Overall protection of human health and the environment; and
2. Compliance with ARARs.

Each alternative must be evaluated to determine how it achieves and maintains protection of human health and the environment. Similarly, each remedial alternative must be assessed to determine how it complies with ARARs, or, if a waiver is required, an explanation of why a waiver is justified. An alternative is considered to be protective of human health and the environment if it complies with media-specific preliminary cleanup goals.

7.1.2 Balancing Criteria

The five balancing criteria represent the primary criteria upon which the detailed analysis of alternatives and the comparison of alternatives are based. They are:

1. Long-term effectiveness and permanence;
2. Reduction of toxicity, mobility, or volume through treatment;
3. Short-term effectiveness; and
4. Implementability; and
5. Cost.

Long-term effectiveness and permanence is an evaluation of the magnitude of residual risk (risk remaining after implementation of the alternative) and the adequacy and reliability of controls used to manage the remaining waste (untreated waste and treatment residuals) over the long term. Alternatives that provide the highest degree of long-term effectiveness and permanence leave little or no untreated waste at the AOC, make long-term maintenance and monitoring unnecessary, and minimize the need for land use controls.

Reduction of toxicity, mobility, or volume through treatment is an evaluation of the ability of the alternative to reduce the toxicity, mobility, or volume of the waste. The irreversibility of the treatment process and the type and quantity of residuals remaining after treatment also are assessed.

Short-term effectiveness addresses the protection of workers and the community during the remedial action, the environmental effects of implementing the action, and the time required to achieve media-specific preliminary cleanup goals.

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during implementation. Technical feasibility assesses the ability to construct and operate a technology, the reliability of the technology, the ease in undertaking additional remedial actions, and the ability to monitor the effectiveness of the alternative. Administrative feasibility is addressed in terms of the ability to obtain approval from federal, state, and local agencies.

Cost analyses provide an estimate of the dollar cost of each alternative. The cost estimates in this report are based on estimating reference manuals, historical costs, vendor quotes, and engineering estimates. Costs are reported in base year 2005 dollars, or present value (future costs are converted to base year 2005 dollars using a 3.1% discount factor). The present value analysis is a method to evaluate expenditures, either capital or O&M, which occur over different time periods. Present value calculations allow for cost comparisons of different remedial alternatives on the basis of a single cost figure. The capital costs have not been discounted due to their relatively short implementation duration. The cost estimates are for guidance in project evaluation and implementation and are believed to be accurate within a range of -30 % to +50 % in accordance with USEPA guidance (USEPA 1988). Actual costs could be higher than estimated due to unexpected conditions or potential delays. Details and assumptions used in developing cost estimates for each of the alternatives are provided in Appendix 7.

7.1.3 Modifying Criteria

The two modifying criteria below will be evaluated as part of the ROD after the public has had an opportunity to comment on the PP. They are:

1. State acceptance; and
2. Community acceptance.

State Acceptance considers comments received from agencies of the state of Ohio. The primary state agency supporting this investigation is the Ohio EPA. Comments will be obtained from state agencies on the FS and the preferred remedy presented in the PP. This criterion will be addressed in the responsiveness summary of the ROD.

Community Acceptance considers comments made by the community, including stakeholders, on the alternatives being considered. Input has been encouraged during the ongoing investigation process to ensure the remedy ultimately selected for RQL is acceptable to the public. Comments will be accepted from the community on the FS and the preferred remedy presented in the PP. This criterion will be addressed in the responsiveness summary of the ROD. Because the actions above have not yet taken place, the detailed analysis of alternatives presented below cannot account for these criteria at this time. Therefore, the detailed analysis is carried out only for the first seven of the nine criteria.

Detailed analyses of the retained remedial alternatives for the RQL are presented below. Each relevant set of alternatives are described and evaluated for each AOC against the criteria outlined in Section 7.1.

7.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR RQL

As described in Chapter 6, four remedial alternatives were retained for RQL:

- Alternative 1: No Action (i.e., no remedial actions or controls conducted onsite);
- Alternative 2: Limited Action (e.g., land use controls and 5-year reviews);
- Alternative 3: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use; and
- Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use.

Each of these alternatives subsequently was analyzed in detail against the seven NCP evaluation criteria as described below. The analysis of these alternatives is summarized in Table 7-1.

7.2.1 Alternative 1: No Action

Under this alternative, contaminated soils would remain in place. Existing access restrictions (e.g., RVAAP perimeter fence) would not be continued. Environmental monitoring would not be performed and no restrictions on land use would be pursued. However, RQL is assumed to be utilized in accordance with the OHARNG Integrated Natural Resources Management Plan (OHARNG 2001) and consistent with the OHARNG established future land use for RQL which forms the basis for the exposure scenarios evaluated under restricted and residential land use (Section 3.2).

7.2.1.1 <u>Overall Protection of Human Health and the Environment</u>

Alternative 1 is not protective of human health for current and anticipated OHARNG land use (Restricted Access). The HHRA calculated HI of 0.2 for non-carcinogenic compounds is below the target level of 1. The calculated total ILCR of 2E-03 for the Security Guard/Maintenance Worker exceeds the target risk of 1E-05 and the CERCLA acceptable risk range of 1E-06 to 1E-04. This total ILCR is driven by dermal exposure to several PAHs including benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; dibenz(a,h)anthracene; and indeno(1,2,3-cd)pyrene.

The Security Guard/Maintenance Worker (assumed to patrol RQL every day for 1 hr) is used to represent actual receptors with more irregular exposure (e.g., a wildlife ecologist who spends several days at the AOC once every few years, security personnel who may periodically evaluate the AOC, or workers engaged in periodic maintenance). This brief exposure time (1 hr/day) on a daily exposure frequency for a total exposure time of 250 hr/year, is a reasonable surrogate for the longer (e.g., 8 hr/day) exposure times of receptors who visit the AOC at a much lower exposure frequency (e.g., a few days/year) for a total exposure time of 8-80 hr/year for the ingestion and inhalation pathways. However, because the dermal exposure route do not account for exposure time, the Security Guard/Maintenance Worker scenario potentially overestimates risks to actual receptors from the dermal pathway (i.e., the Security Guard/Maintenance Worker is exposed 250 days/year as opposed to other receptors that may be exposed 1-10 days/year). Risks for PAHs are driven by the dermal exposure pathway; therefore, the ILCR calculated for these PAHs potentially overestimates risks for actual receptors at RQL. Despite this potential of overestimating the risk calculations for this receptor, only one or two [benzo(a)pyrene only] soil samples at RQL have detected concentrations of these PAHs greater than the preliminary cleanup goals, indicating a very limited extent of contamination. All other contaminants detected in soil have EPCs that are already less than preliminary cleanup goals calculated for the representative receptor (Security Guard/Maintenance Worker). Calculated risks to an Adult Trespasser (8E-04) and a Juvenile Trespasser (2E-04) exceed the high end of the CERCLA acceptable risk range of 1E-04 and are also driven by dermal exposure to a few PAHs. The Trespasser scenario includes similar assumptions [i.e., a trespasser visits RQL 50 (Juvenile) to 75 (Adult) days/year and does not remove contaminated soil from his/her skin]. Because the total risk exceeds the CERCLA acceptable risk range of 1E-06 to 1E-04 for the Security Guard/Maintenance Worker, Alternative 1 is not considered protective of human health for anticipated OHARNG land use at RQL.

Alternative 1 is not protective of human health for future residential land use as represented by the Resident Subsistence Farmer scenario. The HHRA for RQL indicates potential future human health ILCRs could exceed the target risk of 1E-05 and the CERCLA acceptable risk range of 1E-06 to 1E-04 under residential land use. Potential human health risks to a Resident Subsistence Farmer from direct exposure to soil and sediment (via ingestion, dermal contact, and inhalation) under the no action alternative are summarized below:

- Soil HI = 0.5 (adult) and 2 (child), ILCR = 5E-03 (adult) and 3E-03 (child); and
- Sediment HI = 0.5 (adult) and 3 (child), ILCR = 5E-05 (adult) and 6E-05 (child).

These risks are also driven primarily by dermal exposure to PAHs. Alternative 1 provides no protection to human health and the environment over these baseline conditions. Soil and sediment that pose potentially unacceptable risks under potential future residential land use would not be remediated.

There would be no mitigation of calculated risks to ecological receptors from COPECs in soil and sediment under this alternative. Because ecological risks that may occur at RQL are not expected to be severe if detected contaminants are left onsite, the detriment of habitat destruction and disturbance that would result from remediation outweigh any justification for remediation. Under Alternative 1 there would be no loss of vegetation, disruption of soil or sediment, or impairment of adjacent pond and wetlands from increased erosion, leaching or resuspension resulting from remedial actions. Current and future OHARNG land use (restricted access) allows for sustainability of terrestrial habitat for ecological receptors. Aquatic habitat in the RQL pond would be maintained under Alternative 1.

7.2.1.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at RQL are presented in Chapter 4. These enforceable standards would be protective of representative receptors under both Security Guard/Maintenance Worker and Resident Subsistence Farmer land use that could be exposed to COCs at RQL. There are no identified chemical-specific or location-specific ARARs identified for Alternative 1. Action-specific ARARs would not apply unless an action is taken.

7.2.1.3 Long-Term Effectiveness and Permanence

Alternative 1 includes no long-term management measures to prevent exposures to or the spread of contamination. Existing security would discontinue and there would be no control of exposures to AOC contaminants. This alternative does not have controls in place and does not provide any additional new controls in the future. Under current and anticipated OHARNG land use (Restricted Access) as represented by the Security Guard/Maintenance Worker scenario, potential risks to human health and the environment are not considered acceptable as described previously.

Under residential future land use as represented by the Resident Subsistence Farmer scenario, there are potential unacceptable risks to human health, since the impacted soils and sediments would remain in place with no additional controls.

7.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 1 does not reduce contaminant toxicity, mobility, or volume since no treatment process is proposed.

7.2.1.5 Short-Term Effectiveness

There are no significant short-term human health risks associated with Alternative 1 beyond baseline conditions. No additional short-term health risks to the community would occur since no remedial actions would be implemented. There would be no transportation risks nor would workers be exposed to any additional health risks. Alternative 1 would not directly cause adverse impacts on soils, air quality, water resources, or biotic resources.

7.2.1.6 Implementability

No remedial actions are proposed under this alternative.

7.2.1.7 Cost

The present value cost to complete Alternative 1 is zero. No capital costs are associated with this alternative. The no action alternative does not meet NCP threshold evaluation criteria (overall protection of human health and the environment/compliance with ARARs) for the future residential land use scenario.

7.2.2 Alternative 2: Limited Action

Alternative 2 maintains the current status of RQL and includes land use controls and 5-year reviews to identify potential exposures and/or changes in the nature or extent of AOC contamination. Land use controls would be implemented in accordance with an approved RD.

Pursuant to CERCLA, a review would be conducted every five years, as contaminants remain onsite above Resident Subsistence Farmer land use preliminary cleanup goals. These 5-year reviews will evaluate the effectiveness of land use controls and ensure any land use changes are identified.

7.2.2.1 Overall Protection of Human Health and the Environment

Alternative 2 is not protective of human health for current and anticipated OHARNG land use (Restricted Access). The HHRA calculated HI of 0.2 for non-carcinogenic compounds is below the target level of 1. The calculated a total ILCR of 2E-03 for the Security Guard/Maintenance Worker exceeds the target risk of 1E-05 and the CERCLA acceptable risk range of 1E-06 to 1E-04. As noted previously (Section 7.1.1) this total ILCR is driven by dermal exposure to several PAHs and has the potential to overestimate risks for actual receptors at RQL. Despite the nature of the risk calculations, only one or two [benzo(a)pyrene only] soil samples at RQL have detected concentrations of these PAHs greater than the preliminary cleanup goals indicating a very limited extent of contamination. All other contaminants detected in soil have EPCs that are already at concentrations less than preliminary cleanup goals calculated for the Security Guard/Maintenance Worker. Because the total risk exceeds the CERCLA acceptable risk range of 1E-06 to 1E-04 for the Security Guard/Maintenance Worker, Alternative 2 is not considered protective of human health for anticipated OHARNG land use at RQL. As risks to the Resident Subsistence Farmer also exceed the CERCLA acceptable risk range of 1E-06 to 1E-04, Alternative 2 is not considered protective of human health for the future residential land use scenario.

There would be no mitigation of calculated risks to ecological receptors from COPECs in soil and sediment under this alternative. Because ecological risks that may occur at RQL are not expected to be severe if detected contaminants are left onsite, the detriment of habitat destruction and disturbance that would result from remediation outweigh any justification for remediation. Under Alternative 2 there would be no loss of vegetation, disruption of soil or sediment, or impairment of adjacent pond and wetlands from increased erosion, leaching or resuspension resulting from remedial actions. Current and future OHARNG land use (restricted access) allows for sustainability of terrestrial habitat for ecological receptors. Aquatic habitat in the RQL pond would be maintained under this alternative.

7.2.2.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at RQL are presented in Chapter 4. These enforceable standards would be protective of representative receptors under both the Security Guard/Maintenance Worker and residential land use that could be exposed to COCs at RQL. There are no identified chemical-specific or location-specific ARARs identified for Alternative 2. Action-specific ARARs would not apply unless an action is taken.

7.2.2.3 Long-Term Effectiveness and Permanence

Alternative 2 is protective in the long term. It relies on land use controls and maintenance of limited improvements to eliminate or reduce exposures to contaminants. The effectiveness of this approach is related to the adequacy and reliability of the land use controls. However with appropriate documentation and procedures, land use controls can reasonably be expected to be effective in protecting human health and the environment while preserving the land uses required for RQL.

Because contaminants would remain onsite above Resident Subsistence Farmer preliminary cleanup goals, reviews would need to be conducted at least once every five years pursuant to CERCLA requirements. The purpose of these reviews would be to evaluate data obtained from ongoing monitoring and to provide information on the presence and behavior of contaminants, as well as to ensure that land use and engineering controls are retaining effectiveness.

7.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 2 does not involve reduction in contaminant toxicity, mobility, or volume.

7.2.2.5 Short-Term Effectiveness

Alternative 2 would not introduce additional short-term risks to the community. The alternative's remedial measures would require zero years to complete and would include an O&M period (30 years assumed for cost estimating purposes).

7.2.2.6 Implementability

Land use controls and improvements are technically implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs, access restrictions, or cover material. There are currently access restrictions implemented facility-wide and at RQL. Implementing proposed land use controls and AOC improvements would supplement and support restrictions already existing at the AOC.

7.2.2.7 Cost

The present value cost to complete Alternative 2 is approximately $183,946 (in base year 2005 dollars with a 3.1% discount factor). O&M and monitoring costs are estimated for a 30 year period. The development of a RD including land use controls and CERCLA 5-year reviews are included in this cost. Detailed description of Alternative 2 costs are contained in Appendix 7.

7.2.3 Alternative 3: Excavation of Soils/Dry Sediments Offsite Disposal ~ Security Guard/Maintenance Worker Land Use

Alternative 4 includes excavation and offsite disposal to remove impacted soils exceeding restricted land use preliminary cleanup goals (represented by the Security Guard/Maintenance Worker). An estimated 423 yd^3 (ex situ) of PAH-impacted soil would be excavated and shipped offsite to a permitted disposal facility. Other technologies required would include monitoring, short-term containment, and waste handling via trucks.

7.2.3.1 Overall Protection of Human Health and the Environment

In general, the long-term protectiveness of this alternative is high for the intended restricted land use at RQL as represented by the Security Guard/Maintenance Worker.

The HHRA for RQL indicates potential future human health risks from soil are above the target risk of 1E-05 and the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the Security Guard/Maintenance Worker Trainee land use scenario. The potential future human health risk does not exceed HI of 1 for non-carcinogenic compounds for soil.

Alternative 3 includes removal of soil in the quarry to meet the Security Guard/Maintenance Worker land use preliminary cleanup goals. Areas of soil removal are shown in Figure 3B-1 (Appendix 3B) with subsequent confirmation MI sampling. For the purpose of estimating areas of soil removal, the alternative assumes that the MI sample results will not provide justification for further soil/dry sediment removal.

The HHRA estimated potential future human health risks for the restricted land use scenario (represented by a Security Guard/Maintenance Worker) for the no-action alternative (i.e., pre-remediation). As stated in Section 3.3.5.1 and Table 3-7, PAHs (in two sample locations) were the only Feasibility Study constituents of concern (FSCOCs) identified for evaluation in the FS alternatives for the Security Guard/Maintenance Worker National Guard Trainee.

The removal provides reasonable certainty that the total ILCR and total HI across all contaminants will be at or below the thresholds of 1E-05 and 1.0, respectively for the Security Guard/Maintenance Worker. Therefore, this alternative provides overall protection to the representative receptor for human health.

7.2.3.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at RQL are presented in Chapter 4. These enforceable standards would be protective of representative receptors under both the Security Guard/Maintenance Worker and residential land use that could be exposed to COCs at RQL. There are no identified chemical-specific or location-specific ARARs identified for Alternative 3. Action-specific ARARs would not apply unless an action is taken.

7.2.3.3 Long-Term Effectiveness and Permanence

Alternative 3 is protective in the long term for Security Guard/Maintenance Worker land use. Contaminants will remain onsite above preliminary cleanup goals for residential land use. This alternative includes land use controls to eliminate or reduce exposures to receptors. With appropriate documentation and procedures, land use controls can be successfully implemented and would be effective in protecting human health and the environment.

Reviews will be conducted at least once every 5 years, pursuant to CERCLA requirements. CERCLA five-year reviews permit the evaluation of remedy components, including effectiveness of land use controls.

7.2.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 3 does not involve treatment. Therefore, no reduction in contaminant toxicity, mobility, or volume is achieved with this alternative.

7.2.3.5 Short-Term Effectiveness

The short-term effectiveness of Alternative 3 includes the potential for worker exposure during the excavation process as well as the exposure to the community during transportation of soil. Workers would follow a health and safety plan and wear appropriate personal protective equipment (PPE) to minimize exposures. Mitigation measures would be used to minimize short-term impacts, such as erosion and dust control during construction.

Excavated soil will be transported by truck to a disposal facility. Risks will be mitigated during transport by inspecting vehicles before and after use, decontaminating when needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance the waste is transported in vehicles. Transportation risks (e.g., from continuous leaks) increase with distance and volume. Transportation of contaminated materials to an offsite disposal facility would strictly comply with all applicable state and federal regulations. Pre-designated routes would be traveled and an emergency response program developed to facilitate accident response.

Remedial actions are estimated to require approximately one month to complete, followed by 30 years of O&M. Upon the completion of the excavation activities, RQL would be released for Security Guard/Maintenance Worker land use.

7.2.3.6 Implementability

Alternative 3 is technically implementable. Excavation of impacted sediment, construction of temporary roads, and waste handling are conventional activities in construction projects of this kind. Multiple disposal facilities are available that can accept generated waste. Construction and operation of the components of Alternative 3 would be straightforward with resources readily available to complete the remedial activity. However, special engineering techniques may be required during construction activities to deal with potential MEC issues at RQL. Borrow sites for backfill and soil cover have not been selected, but are anticipated to be locally available.

The acceptability of Alternative 3 would be affected by administrative requirements for transport and disposal and the requirements for Security Guard/Maintenance Worker land use. Local engineering departments would be consulted to evaluate the impact of the truck traffic on the roads surrounding the RVAAP.

Land use controls also are implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs, access controls, or cover material. RQL currently has access restrictions implemented at the AOC.

Careful planning would be needed between remedial action planners and OHARNG to minimize disruptions and/or impacts to OHARNG operations during implementation. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be taken to minimize hazards posed to onsite personnel. This type of planning will increase the implementation difficulty of Alternative 3, but also will reduce the risks to personnel.

7.2.3.7 Cost

The present value cost to complete Alternative 3 is approximately $301,978 (in base year 2005 dollars with a 3.1 % discount factor). O&M costs including monitoring and imposition of land use controls are estimated for a 30-year period. In addition, 5-year reviews are required throughout the costing period and are included in the estimate. See Appendix 7 for a detailed description of Alternative 3 costs.

7.2.4 Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use

Alternative 4 includes excavation and offsite disposal to remove impacted soils exceeding residential land use preliminary cleanup goals (represented by the Resident Subsistence Farmer). An estimated 815 yd^3 (ex situ) of PAH-impacted soil would be excavated and shipped offsite to a permitted disposal facility.

Subsequent confirmation MI sampling will be conducted. For the purpose of estimating areas of soil removal, the alternative assumes that the MI sample results will not provide justification for further soil/dry sediment removal. Other technologies required would include monitoring, short-term containment, and waste handling via trucks.

7.2.4.1 **Overall Protection of Human Health and the Environment**

In general, the long-term protectiveness of this alternative is high. Alternative 4 includes removal of soil to meet the Resident Subsistence Farmer preliminary cleanup goals in surface soil. Removing soil containing contaminants above Resident Subsistence Farmer preliminary cleanup goals would limit cancer risks to below or equal to the target risk (and within the CERCLA acceptable cancer risk range) and to a non-carcinogenic HI of less than 1 except for risks driven by naturally occurring background concentrations of metals (e.g., the post-remediation chemical-specific ILCR from background values of arsenic will remain in the range of 2E-05 to 3E-05).

The remedial actions taken to protect human health will also reduce risks to ecological receptors that occupy or visit this AOC. There would be a temporary loss of vegetated habitat, disruption of soil and sediment, and potential impairment of adjacent pond and wetlands from increased erosion, leaching or resuspension resulting from remedial actions. With erosion control and other engineering precautions, the adverse effects of these impacts would be mitigated. Current and future OHARNG land use (restricted access) allows for sustainability of terrestrial habitat for ecological receptors. Aquatic habitat in RQL pond would eventually increase in quality due to remedial actions under this alternative; however, the aquatic habitat/wetlands quality is naturally limited because of the man-made/quarry nature of the land features.

7.2.4.2 **Compliance with ARARs**

Potential ARARs for remediation of soils/dry sediments at RQL are presented in Chapter 4. These enforceable standards would be protective of representative receptors under Resident Subsistence Farmer land use who could be exposed to COCs at RQL. There are no identified chemical-specific or location-specific ARARs identified for Alternative 4. Action-specific ARARs would not apply unless an action is taken.

7.2.4.3 **Long-Term Effectiveness and Permanence**

Alternative 4 would effectively reduce the long-term contamination for soils at RQL. All soils above Resident Subsistence Farmer land use cleanup goals would be excavated and transported offsite for disposal, thereby mitigating risks to human health and the environment. Confirmatory sampling would be conducted after excavation activities to confirm Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Accordingly, land use controls will not be required upon the completion of the removal activities. No CERCLA 5-year reviews or O&M sampling are required.

7.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 4 does not achieve a reduction in the toxicity, mobility, or volume of impacted soils.

7.2.4.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 4 includes potential exposures to workers during excavation and the community during transportation of impacted soils. Workers would follow a health and safety plan and wear appropriate PPE to minimize exposures. Mitigation measures such as erosion and dust control during construction would ensure minimal short-term impacts.

Risks of potential exposures to the community will be minimized by inspecting vehicles before and after use, decontaminating when needed, covering the transported waste, observing safety protocols, following pre-designated routes, and limiting the distance the waste is transported. Transportation risks (e.g., from continuous leaks) increase with distance and volume. Transportation of contaminated materials to an offsite disposal facility would strictly comply with all applicable state and federal regulations. Pre-designated routes would be traveled and an emergency response program would be developed to respond to any accidents.

Remedial actions would require approximately one month to implement. The relatively short duration of remedial activities further reduces overall exposure risks to workers and the community from operations.

7.2.4.6 Implementability

Alternative 4 is technically and administratively implementable. Remedial activities under this alternative involve conventional construction operations such as excavation of impacted soils, construction of temporary roads, and onsite truck transport. Resources are readily available for removing soil and standard excavation and construction equipment would be used. Multiple disposal facilities are available that can accept the waste. Borrow sites for backfill and soil cover have not been selected, but are anticipated to be locally available. Special engineering techniques may be required during construction activities to deal with potential MEC issues at RQL.

The acceptability of Alternative 4 would be affected by the administrative requirements for transport and disposal. Local engineering departments would be consulted to evaluate potential impacts of the truck traffic on roads surrounding the RVAAP.

Careful planning would be needed between remedial action planners and OHARNG to minimize disruptions and/or impacts to OHARNG operations during implementation of the alternative. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be taken to minimize hazards posed to onsite personnel. This type of planning will increase the difficulty of implementing Alternative 4, but also will reduce the risks to onsite personnel.

7.2.4.7 <u>Cost</u>

The present value cost to complete Alternative 4 is approximately $215,465 (in base year 2005 dollars with a 3.1% discount factor). Impacted soil removal, disposal and subsequent confirmation sampling are included in this cost. This alternative does not include an O&M period subsequent to the soil removal. See Appendix 7 for a detailed description of Alternative 3 costs.

7.2.5 Comparative Analysis of RQL Alternatives Using NCP Criteria

In this section, a comparative analysis of the four alternatives applicable to RQL is conducted to identify relative advantages and disadvantages of each based on the detailed analysis above. The comparative analysis provides a means by which remedial alternatives can be directly compared to one another with respect to common criteria. Overall protection and compliance with ARARs are threshold criteria that must be met by any alternative to be eligible for selection. The other criteria, consisting of short- and long-term effectiveness; reduction of contaminant toxicity, mobility, or volume through treatment; ease of implementation; and cost are the primary balancing criteria used to select a preferred remedy among alternatives satisfying the threshold criteria. A summary table illustrating the comparative analysis is provided in Table 7-2. The process for obtaining community and state acceptance is described in Chapter 8.

As described above, four remedial alternatives were retained and analyzed in detail for RQL:

- Alternative 1: No Action;
- Alternative 2: Limited Action;
- Alternative 3: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use; and
- Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use.

The relative advantage and disadvantages of these four alternatives is described below.

7.2.5.1 <u>Overall Protection of Human Health and the Environment</u>

Alternatives 1 and 2 are not protective of human health for anticipated OHARNG land use. The calculated total ILCR of 2E-03 for the Security Guard/Maintenance Worker exceeds the target risk of 1E-05 and the CERCLA acceptable risk range of 1E-06 to 1E-04.

Alternatives 3 and 4 are protective under the Security Guard/Maintenance Worker land use scenario. These alternatives remove soil in the quarry to meet the land use preliminary cleanup goals. Removal of the soil provides reasonable certainty that the total ILCR and total HI across all contaminants will be at or below thresholds of 1E-05 and 1.0 respectively for the Security Guard/Maintenance Worker. Alternative 4 meets the Resident Subsistence Farmer preliminary cleanup goals.

Current and future land uses (military security guard/maintenance worker) allow for sustainable terrestrial habitat for ecological receptors. Aquatic habitat in the RQL pond also would be maintained under these alternatives.

7.2.5.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at RQL are presented in Chapter 4. Each alternative, except Alternative 1 (No Action), could be designed and implemented to meet respective ARARs.

7.2.5.3 Long-Term Effectiveness and Permanence

Alternative 1 is rated low in terms of long-term effectiveness in preventing exposures or the spread of contamination. Alternative 1 does not involve any remedial actions or land controls for potential future exposure. Alternative 2 utilizes land use controls and is considered moderately effective and permanent since such controls can potentially fail. Alternative 2 is nonetheless considered more effective and permanent than Alternative 1 and is rated medium. The long-term effectiveness and permanence of Alternatives 3 and 4 is considered high. These alternatives are highly permanent and effective since these alternatives involve the removal of AOC contamination and achievement of either the Security Guard/Maintenance Worker or Resident Subsistence Farmer land use preliminary cleanup goals.

7.2.5.4 Reduction in Contaminant Volume, Toxicity, and Mobility through Treatment

The ability of Alternatives 1, 2, 3, and 4 to reduce contaminant volume, toxicity and mobility is low since these alternatives do not involve treatment.

7.2.5.5 Short-Term Effectiveness

No additional short-term risks to the community are associated with Alternatives 1 and 2 since no remediation activities are conducted for these alternatives. Correspondingly no transportation risks, potential for worker exposure, or short-term risks to the community beyond baseline conditions are associated with these alternatives. Therefore, Alternatives 1 and 2 are rated high. The short-term effectiveness of Alternatives 3 and 4 is affected by potential accidents from excavation and transportation of impacted soils and exposure of workers to impacted sediment. Although mitigation measures would be implemented to reduce or eliminate these risks/exposures, this alternative is assigned a medium rating.

7.2.5.6 Implementability

All alternatives are considered implementable on a technical and availability-of-services basis. Alternative 1 is a No Action alternative is rated high. Alternative 2 involves implementing land use controls at RQL. Since RVAAP currently has facility-wide land use controls in effect, implementing and maintaining additional AOC-specific land use controls should not be difficult. Consequently, Alternative

2 is also rated highly. Soil removal and disposal under Alternatives 3 and 4 should be readily implementable, but not as easily as Alternatives 1 and 2. Therefore, Alternatives 3 and 4 are assigned a medium rating.

7.2.5.7 Cost

Costs were estimated for comparison purposes only and are believed accurate within a range of -30% to +50%. The estimated present value cost (in base year 2005 dollars with a 3.1% discount factor) to complete each of the alternatives is as follows: In comparison of Alternatives 3 and 4, Alternative 3 has a lower soil removal cost and included an O&M period (as seen in Appendix 7), which is assumed to be required for the land adjacent to a landfill. Therefore, with regards to cost, Alternative 3 would be a more viable and realistic option.

Alternative 1:	$	0
Alternative 2:	$	183,946
Alternative 3:	$	301,978
Alternative 4:	$	215,465

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for RQL

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use	Alternative 4 Excavation of Soils/Dry Sediments, and Offsite Disposal ~ Resident Subsistence Farmer Land Use
1. Overall Protectiveness				
Human Health Protection	Not protective for anticipated OHARNG future land use (Security Guard/Maintenance Worker). Not protective for residential land use.	Not protective for anticipated OHARNG future land use (Security Guard/Maintenance Worker). Not applicable to residential land use.	Protective due to removal of impacted soils and institution of land use controls.	Protective due to removal of impacted soils.
Environmental Protection	No mitigation of calculated risks to ecological receptors; however, ecological risks are not likely to be high, based on AOC reconnaissance and low COPEC concentrations.	No mitigation of calculated risks to ecological receptors; however, ecological risks are not likely to be high, based on AOC reconnaissance and low COPEC concentrations.	Remedial actions taken to protect human health also will reduce risks to ecological receptors. Excavation would result in a temporary loss of vegetated habitat.	Remedial actions taken to protect human health also will reduce risks to ecological receptors. Excavation would result in a temporary loss of vegetated habitat
2. Compliance with ARARs				
ARARs	Not compliant.	Complies with ARARs under restricted land use and precludes future residential land use assuming land use controls are maintained.	Complies with ARARs under residential land use.	Complies with ARARs under residential land use.
3. Long-Term Effectiveness and Permanence				
Magnitude of Residual Risk	Residual risk for future residential land use exceeds USEPA risk range due to contamination remaining in place with no additional access restrictions.	Residual risk for future residential land use exceeds USEPA risk range due to current contamination remaining in place with no additional access restrictions.	Residual risk/ hazard exceeds target risk/hazard for residential land use.	Meets preliminary remedial goals without restrictions with respect to soils and dry sediment on future land use.
Adequacy and Reliability of Controls	No land use controls.	Land use controls considered adequate and reliable.	Land use controls adequate and reliable.	No land use controls required for soils and dry sediments.
Long-Term Management	None.	Required since soils would remain onsite in exceedance of residential land-use cleanup goals.	Required since soils would remain onsite in exceedance of residential land-use cleanup goals.	No long-term management required as residential land use achieved.

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for RQL (continued)

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use
4. Reduction of Toxicity, Mobility, or Volume through Treatment				
Reduction through Treatment	None (no treatment).	None (no treatment).	None (no treatment).	None (no treatment).
5. Short-Term Effectiveness				
Community	No immediate increased risk to community.	No immediate increased risk to community.	Slight risk due to construction and transportation activities. Controlled by mitigating measures.	Slight risk due to construction and transportation activities. Controlled by mitigating measures.
Workers	No significant increase of risks or hazards to workers.	No significant increase of risks or hazards to workers.	Workers may be exposed to impacted soils, as well as heavy equipment hazards. Safety measures would mitigate risks.	Workers may be exposed to impacted soils, as well as heavy equipment hazards. Safety measures would mitigate risks.
Ecological Resources	Continued potential for impacts from existing conditions.	Continued potential for impacts from existing conditions.	Excavation would result in a temporary loss of vegetated habitat. Potential short-term environmental impacts minimized by land use controls.	Excavation would result in a temporary loss of vegetated habitat. Potential short-term environmental impacts minimized by land use controls.
Land use controls	None.	None.	Potential releases controlled with management and engineering practices.	Potential releases controlled with management and engineering practices.
Time to Complete[1]	0 years	0 years	1 month	1 month
O&M Period	0 years	30 years (estimated)	30 years (estimated)	0 years
6. Implementability				
Technical Feasibility	Not applicable	Feasible.	Feasible.	Feasible.
Administrative Feasibility	Not applicable	Relatively easy. Land use controls are currently being implemented at AOC.	Relatively easy.	Relatively easy.

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for RQL (continued)

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use
7. Cost				
Estimated Cost[2]	$0	$183,946	$301,978	$215,465

[1]Time to complete remedial action after completion of remedial design, assuming timely project funding. Does not include O&M period.

[2]Estimated costs calculated as net present value in base year 2005 dollars using a 3.1% discount factor. A 30-year O&M period is assumed for cost estimating purposes.

AOC = Area of concern.

ARAR = Applicable and relevant or appropriate requirements.

COPEC = Constituent of potential ecological concern.

NCP = National Contingency Plan.

OHARNG = Ohio Army National Guard.

O&M = Operation and maintenance.

USEPA = U. S. Environmental Protection Agency.

Table 7-2. Summary of Comparative Analysis of Remedial Alternatives for RQL

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use	Alternative 4 Excavation of Soils/Dry Sediments, and Offsite Disposal ~ Resident Subsistence Farmer Land Use
1. Overall Protectiveness	Not protective	Not protective	Protective	Protective
2. Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant
3. Long-Term Effectiveness and Permanence	Low	Medium	High	High
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Low	Low	Low	Low
5. Short-Term Effectiveness	High	High	Medium	Medium
6. Implementability	High	High	Medium	Medium
7. Cost	High $0	Medium $183,946	Medium $301,978	Medium $215,465

ARAR = Applicable and relevant or appropriate requirements.
NCP = National Contingency Plan

8.0 AGENCY COORDINATION AND PUBLIC INVOLVEMENT

The US Army is the lead agency under the Defense Environmental Restoration Program responsible for achieving remedy of the six high priority AOCs at RVAAP, including RQL. This chapter reviews actions that have been conducted and that are planned in the future to ensure regulatory agencies and the public have been provided with appropriate opportunities to stay informed of progress of the six high priority environmental AOC's remediation and to provide meaningful input on the planning effort as well as the final selection of a remedy.

As described in Chapter 7, two of the nine NCP evaluation criteria are known as "modifying criteria." These are state acceptance and community acceptance. These criteria provide a framework for obtaining the necessary agency coordination and public involvement in the remedy selection process.

8.1 STATE ACCEPTANCE

State acceptance considers comments received from agencies of the State of Ohio on the remedial alternatives being considered. For the process supporting remedy of the six high priority AOCs, including RQL, Ohio EPA is the lead regulatory agency and this FS has been prepared in consultation with Ohio EPA. Ohio EPA has provided input during the ongoing investigation and report development process to ensure the remedy ultimately selected for the six high priority AOCs, including RQL, meets the needs of the state of Ohio and fulfills the requirements of the DFFO (Ohio EPA 2004a). Comments will be solicited from Ohio EPA on the FS and on the PP. The US Army will obtain Ohio EPA concurrence prior to the final selection of the remedy for RQL.

8.2 COMMUNITY ACCEPTANCE

Community acceptance considers comments provided by the community on the remedial alternatives being considered. CERCLA 42 U.S.C. 9617(a) emphasizes early, constant, and responsive community relations. The US Army has prepared a Community Relations Plan (USACE 2003b) for this project to ensure the public has convenient access to information regarding project progress. The community relations program interacts with the public through news releases, public meetings, public workshops, and Restoration Advisory Board (RAB) meetings with local officials, interest groups, and the general public. The public also is provided the opportunity to comment on draft documents submitted to the Administrative Record that support remedy of RQL, including the previously completed RI Report and this FS.

CERCLA 42 U.S.C. 9617(a) requires that an Administrative Record be established "at or near the facility at issue." Relevant documents regarding the RVAAP have been made available to the public for review and comment. The ***Administrative Record*** for this project is available at the following location:

Ravenna Army Ammunition Plant
Building 1037 Conference Room
8451 St. Route 5
Ravenna, Ohio 44266-9297

Access to RVAAP is restricted but can be obtained by contacting facility management at (330) 358-7311. In addition, an Information Repository of current information and final documents is available to any interested reader at the following libraries:

Reed Memorial Library
167 East Main Street
Ravenna, Ohio 44266

Newton Falls Public Library
204 South Canals
Newton Falls, Ohio 44444-1694

Also, RVAAP has an online resource for restoration news and information. This website is available at: www.rvaap.org.

Similar to state agencies, comments will be received from the community upon issuance of the FS and the PP. The US Army will request public comments on the PP for RQL, as required by the CERCLA regulatory process and the RVAAP Community Relations Plan. These comments will be considered in the final selection of a remedy for RQL. Responses to these comments will be addressed in the responsiveness summary of the ROD.

9.0 CONCLUSIONS AND RECOMMENDED ALTERNATIVE

9.1 CONCLUSIONS

The primary purpose of this FS is to develop, screen, and evaluate remedial alternatives for RQL using data collected during previous investigations. This FS examined the history of RQL and previous investigations, developed media-specific preliminary cleanup goals and remedial actions objectives for the AOC, and screened a range of technologies potentially applicable for meeting these preliminary cleanup goals.

Chemical-specific preliminary cleanup goals were established for restricted and residential land use. Preliminary cleanup goals for restricted land use were established for a representative receptor (Security Guard/Maintenance Worker) for likely future land use by OHARNG. In addition to the Security Guard/Maintenance Worker, preliminary cleanup goals were established for a Resident Subsistence Farmer (adult and child) to provide a baseline for evaluating whether this AOC may be eligible for unrestricted release.

The FS establishes one RAO and evaluates a range of remedial actions to reduce risks to the environment to obtain remedy for (or cleanup of) of RQL with respect to soils/dry sediments. The RAO analysis identified COCs in impacted soils/dry sediments at RQL requiring further evaluation of potential remedial alternatives for a residential land use scenario. The RAO analysis indicates current Security Guard/Maintenance Worker land use is protective with respect to impacted soils. Therefore, technologies were screened and the following potential remedial alternatives were developed:

- Alternative 1: No Action;
- Alternative 2: Limited Action;
- Alternative 3: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use; and
- Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use.

These alternatives, where applicable, were assessed and compared against one another to provide information of sufficient quality and quantity to justify the selection of a remedy. Excavation efforts are estimated to go to a depth of 1 ft BGS, which is at or near the depth of bedrock in the quarry. Land use controls prohibiting soil disturbance are not needed for soil below 3 ft in depth because it is assumed bedrock is less than 3 ft BGS.

The next step in the CERCLA process is to prepare a PP to solicit public input on the remedial alternatives. The PP will present alternatives evaluated in the FS together with the preferred alternative for RQL.

The ROD will document the remedy for RQL. Comments on the PP received from state and federal agencies and the public will be considered in drafting the ROD for RQL. 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 PP.

9.2 RECOMMENDED ALTERNATIVE

The Recommended Alternative for RQL is Alternative 3 (Excavation of Soils and Offsite Disposal ~ Security Guard/Maintenance Worker Land Use). This alternative involves the removal of soils at RQL that exceed preliminary cleanup goals for the Security Guard/Maintenance Worker at locations RQL-025 and RQL-026. MI confirmation sampling would be conducted for 1) hotspot removal areas to confirm preliminary cleanup goals have been achieved and 2) soil/dry sediment media in other areas of the quarry bottom previously sampled using MI sampling methods in the Phase I RI. This confirmation sampling will dictate whether additional land use controls or further removal of soil/dry sediment is required.

Assuming removal beyond the extent of the RQL-025 and RQL-026 hotspot areas is not needed, the cost for the alternative is estimated to be $301,978. Following the removal, land use controls and 5-year reviews will be necessary. Access restrictions are already being implemented at RQL and reinforcement of these controls will bolster the protectiveness of Alternative 3.

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Appendix 2
Risk Characterization for Trespasser Scenario

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2.0 RISK CHARACTERIZATION FOR TRESPASSER SCENARIO

2.1 INTRODUCTION

The baseline HHRA provided in the RI Report for RQL evaluates the potential health risks to humans resulting from exposure to contamination within each AOC. The HHRA presented in the RI Report is based on the methods outlined in the RVAAP FWHHRAM (USACE 2004) dated January 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 2005c) released in November 2005. The Trespasser (Juvenile and Adult) is evaluated in this FS to supplement the baseline HHRA provided in the RI Report to comply with the revised FWHHRAM and 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 2.2 of this appendix;
- Exposure assessment is presented in Section 2.3;
- Toxicity assessment is summarized in Section 2.4;
- Results of the risk characterization are presented in Section 2.5;
- The uncertainty analysis is presented in Section 2.6; and
- The conclusions of the HHRA are summarized in Section 2.7.

2.2 DATA EVALUATION

Data evaluation and COPC screening were conducted as part of the baseline HHRA for RQL (RVAAP-01) in the Phase I RI Report for RQL (USACE 2005b).

Under this scenario, the Trespasser (Juvenile and Adult) may be exposed to COPCs in shallow surface soil (0-1 ft 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 is provided in Table 2-1 below.

Table 2-1. Exposure Media Evaluated for the Trespasser (Juvenile and Adult) Scenario

AOC	Exposure Media		
	Shallow Surface Soil[a]	Sediment	Surface Water
RQL	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.
RQL = Ramsdell Quarry Landfill.
No COPCs = No constituents of potential concern (COPCs) identified for this exposure medium in the Remedial Investigation (RI) Report.

A summary of the COPCs identified for each medium in the baseline HHRA is provided in Table 2-2 below.

Table 2-2. COPCs for each Exposure Medium

COPC	Shallow Surface Soil (0-1 ft BGS)	Sediment	Surface Water
Quantitative COPCs[a]			
Inorganics			
Aluminum	X	X	X
Antimony	X		
Arsenic	X	X	X
Cadmium	X	X	
Chromium[b]	X	X	
Copper	X		
Lead[c]	X		
Thallium	X	X	
Vanadium	X	X	X
Organics			
1,3-Dinitrobenzene	X		
2,4,6-Trinitrotoluene	X		
2,6-Dinitrotoluene	X		
2-Methylnaphthalene	X		
Benz(a)anthracene	X		
Benzo(a)pyrene	X	X	
Benzo(b)fluoranthene	X		
Benzo(k)fluoranthene	X		
Carbazole	X		
Chrysene	X		
Dibenz(a,h)anthracene	X		
Dibenzofuran	X		
Fluoranthene	X		
Fluorene	X		
Indeno(1,2,3-cd)pyrene	X		
Naphthalene	X		
Pyrene	X		

Table 2-2. COPCs for each Exposure Medium (continued)

COPC	Shallow Surface Soil (0-1 ft BGS)	Sediment	Surface Water
Qualitative COPCs[d]			
Inorganics			
Sulfate			X
Organics			
2-Amino-4,6-dinitrotoluene	X		
4-Amino-2,6-dinitrotoluene	X		
Acenaphthylene	X		
Benzo(g,h,i)perylene	X	X	
Nitrocellulose		X	
Nitroglycerin	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 = Chemical is a COPC for this medium.

2.3 EXPOSURE ASSESSMENT

One receptor [Trespasser (Juvenile and Adult)] is evaluated in this supplemental HHRA. RVAAP/ RTLS is a controlled access facility (it is fenced, gated, and patrolled by security guards); however, a trespasser could enter the property and be exposed to contaminants in surface soil (0-1 ft BGS), sediment, and surface water at RQL. The Juvenile Trespasser is assumed to visit the AOC approximately one time per week (i.e., 50 days/year) between the ages of 8 and 18. The Adult Trespasser is assumed to visit the AOC slightly more often (75 days/year) for as long as he 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 surface soil (0-1 ft BGS) and sediment via incidental ingestion, inhalation of 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 2005c) and are provided in Table 2-3 of this appendix. Chemical-specific exposure parameters are provided for all COPCs in Table 2-4 at the end of this appendix.

Table 2-3. 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 2-4
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
Body weight (Adult/Juvenile)	kg	70/45
Volatilization factor	m^3/kg	Chemical Specific – Table 2-4
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

Table 2-3. 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
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 2-4
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
Body weight (Adult/Juvenile)	kg	70/45
Volatilization factor	m^3/kg	Chemical Specific – Table 2-4
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

Table 2-3. Exposure Parameters for Trespasser (Juvenile and Adult) Scenario[a] (continued)

Exposure Pathway and Parameter	Units	Value
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 Amendment 1 (USACE 2005c).
[b]Surface soil is defined as 0-1 ft BGS (shallow surface soil).
BGS = Below ground surface.
VOC = Volatile organic compound.

EPCs were calculated for each exposure medium in the baseline HHRA, as detailed in the RI Report. These EPCs are provided in Tables 2-9 through 2-20 at the end of this appendix.

2.4 TOXICITY ASSESSMENT

Toxicity factors from USEPA sources are provided in Table 2-5 (non-cancer reference doses [RfDs]) and Table 2-6 (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.

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 2-5 and 2-6 at the end of this appendix.

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

Per the FWHHRAM (USACE 2004) toxicity equivalent 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 sulfate; 2-amino-4,6-DNT; 4-amino-2,6-DNT; nitrocellulose; nitroglycerin; acenaphthylene; 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.USEPA.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 2-7 (Juvenile Trespasser) and 2-8 (Adult Trespasser) at the end of this appendix. The Integrated Exposure Uptake Biokinetic (IEUBK) model for lead in children (available at http://www.USEPA.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 model applies to children age 0 to 6 years.

2.5 RISK CHARACTERIZATION FOR TRESPASSER AT RQL

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 COCs are presented in the following subsections. COCs are defined as COPCs having an ILCR greater than 1.0E-06 and/or an HI greater than 1.

2.5.1 RQL Surface Soil (0-1 ft BGS)

Detailed hazard and risk results for direct contact with COPCs in shallow surface soil (0-1 ft BGS) are presented in Tables 2-9 and 2-10 (Juvenile Trespasser) and 2-11 and 2-12 (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 the Adult Trespasser exposed to shallow surface soil (0-1 ft BGS) are 0.057 and 0.070, respectively, which are below the threshold of 1.0; thus, no non-carcinogenic shallow surface soil COCs are identified at RQL for either receptor.

The total risks across all COPCs for the Juvenile Trespasser and the Adult Trespasser exposed to shallow surface soil are 2.0E-04 and 7.6E-04, respectively, coming predominantly from PAHs and arsenic. Seven carcinogenic shallow surface soil COCs are identified [arsenic (Adult Trespasser only); benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; benzo(k)fluoranthene (Adult Trespasser only); dibenz(a,h)anthracene; and indeno(1,2,3-cd)pyrene].

Five of the seven carcinogenic shallow surface soil COCs have risks in excess of Ohio EPA's level of concern of 1E-05: benz(a)anthracene; benzo(a)pyrene; benzo(b)fluoranthene; dibenz(a,h)anthracene; and indeno(1,2,3-cd)pyrene (Adult Trespasser only). One sample (RQL-026) highly influences the carcinogenic risk results, as the maximum detected concentration comes from this sample for six of the seven COCs (all except arsenic). For these six COCs, the next largest concentration is 1 to 2 orders of magnitude lower than the concentrations detected in sample RQL-026.

Lead was identified as a shallow surface soil COPC at RQL. Lead model results for the Juvenile Trespasser and Adult Trespasser are provided in Tables 2-7 and 2-8, respectively, at the end of this appendix. The estimated probability of fetal blood lead concentrations exceeding acceptable levels is less than 3% for a Juvenile Trespasser exposed to shallow surface soil at RQL; the estimated probability of fetal blood lead concentrations exceeding acceptable levels is 2% or less for an Adult Trespasser exposed to shallow surface soil at RQL; therefore, lead is not a COC.

2.5.2 RQL Sediment

Detailed hazard and risk results for direct contact with COPCs in sediments are presented in Tables 2-13 and 2-14 (Juvenile Trespasser) and 2-15 and 2-16 (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 0.038 and 0.042, respectively, which are below the threshold of 1.0; thus, no non-carcinogenic sediment COCs are identified at RQL for either receptor.

The total risks across all COPCs for the Juvenile Trespasser and Adult Trespasser exposed to sediment are 1.6E-06 and 5.7E-06, coming predominantly from arsenic. Arsenic is identified as a sediment COC at RQL for these receptors, with individual cancer risks of 1.4E-06 (Juvenile Trespasser) and 4.7E-06 (Adult Trespasser), both below Ohio EPA's level of concern of 1E-05 (Ohio EPA 2004b).

2.5.3 RQL Surface Water

Detailed hazard and risk results for contact with COPCs in surface water are presented in Tables 2-17 and 2-18 (Juvenile Trespasser) and 2-19 and 2-20 (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 0.31 and 0.23, respectively, which are below the threshold of 1.0; thus, no non-carcinogenic surface water COCs are identified at RQL for either receptor.

The total risks across all COPCs for the Juvenile Trespasser and Adult Trespasser exposed to sediment are 2.6E-06 and 6.5E-06, respectively. Arsenic and aldrin (Adult Trespasser only) are identified as surface water COCs at RQL. Individual cancer risks for these two COCs (1.9E-06 and 5.1E-06 for arsenic for the Juvenile Trespasser and Adult Trespasser, respectively, and 1.4E-06 for aldrin for the Adult Trespasser) - are below Ohio EPA's level of concern of 1E-05.

2.5.4 Summary of Risk Characterization Results for Trespasser at RQL

Risks, hazards, and COCs are summarized in Table 2-21 for the Trespasser (Juvenile and Adult) exposed to shallow surface soil (0-1 ft BGS), sediment, and surface water at RQL.

Table 2-21. Summary of Risks and Hazards for Trespasser (Juvenile and Adult) at RQL

Exposure Medium	Total HI	Non-Carcinogenic COCs	Total ILCR	Carcinogenic COCs
Juvenile Trespasser				
Shallow Surface Soil (0-1 ft BGS)	0.057	None	2.0E-04	benz(a)anthracene benzo(a)pyrene benzo(b)fluoranthene dibenz(a,h)anthracene indeno(1,2,3-cd)pyrene
Sediment	0.038	None	1.6E-06	arsenic
Surface Water	0.31	None	2.6E-06	arsenic
Adult Trespasser				
Shallow Surface Soil (0-1 ft BGS)	0.070	None	7.6E-04	arsenic benz(a)anthracene benzo(a)pyrene benzo(b)fluoranthene benzo(k)fluoranthene dibenz(a,h)anthracene indeno(1,2,3-cd)pyrene

Table 2-21. Summary of Risks and Hazards for Trespasser (Juvenile and Adult) at RQL

Exposure Medium	Total HI	Non-Carcinogenic COCs	Total ILCR	Carcinogenic COCs
Sediment	0.042	None	5.7E-06	arsenic
Surface Water	0.23	None	6.5E-06	arsenic aldrin

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

2.6 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 2004), and OHARNG will manage the property, there is uncertainty surrounding the future land use. To address this uncertainty a Trespasser (Juvenile and Adult) is evaluated in this supplemental risk assessment.

2.7 SUMMARY AND CONCLUSIONS

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

- Identification of COPCs (in the baseline HHRA included in the RI Report for RQL);
- Calculation of risks and hazards; and
- Identification of COCs.

At RQL, all HIs for the Trespasser (Juvenile and Adult) are below the threshold value of 1.0. The total ILCRs for shallow surface soil (0-1 ft BGS), sediment, and surface water exceed the threshold value of 1E-06. Six PAHs and arsenic are identified as COCs in shallow surface soil; arsenic is identified as a COC in sediment; and arsenic and aldrin are identified as COCs in surface water.

Table 2-4. 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	--
Cadmium	1.0E-03	3.5E-04	--
Chromium (as Chromium VI)	1.0E-03	1.0E-03	--
Copper	1.0E-03	3.1E-04	--

Table 2-4. Chemical-Specific Exposure Parameters (continued)

COPC	Dermal Absorption Factor[a] (unitless)	Permeability Constant[b] (cm/hr)	Volatilization Factor[c] (m^3/kg)
Thallium (as Thallium carbomate)	1.0E-03	1.6E-04	--
Vanadium	1.0E-03	1.4E-03	--
Organics			
1,3-Dinitrobenzene	1.0E-01	2.1E-03	4.6E+04
2,4,6-Trinitrotoluene	1.0E-01	1.1E-03	--
2,6-Dinitrotoluene	1.0E-01	4.6E-03	--
2-Methylnaphthalene	1.0E-01	1.4E-01	2.6E+05
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	--
Benzo(k)fluoranthene	1.3E-01	1.2E+00	--
Carbazole	1.0E-01	8.0E-02	--
Chrysene	1.3E-01	1.0E+00	--
Dibenz(a,h)anthracene	1.3E-01	1.7E+00	--
Dibenzofuran	1.0E-01	1.5E-01	--
Fluoranthene	1.3E-01	5.1E-01	--
Fluorene	1.0E-01	1.7E-01	--
Indeno(1,2,3-cd)pyrene	1.3E-01	2.2E+00	--
Naphthalene	1.3E-01	6.9E-02	6.4E+04
Pyrene	1.3E-01	3.2E-01	--

[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 = U. S. Environmental Protection Agency.
VOC = Volatile organic compound.
-- = No value available.

Table 2-5. 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
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	
Thallium	8.0E-05	Low	1	8.0E-05	--	Oral (rat)	Increased levels of SGOT and LDH	UF=3000
Vanadium	7.0E-03	Low	0.026	1.8E-04	--	Oral (rat)	Decreased hair cystine	UF=100

Table 2-5. 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
Organics								
1,3-Dinitrobenzene	1.0E-04	Low	1	1.0E-04	--	Oral (rat)	Increased splenic weight	(O) UF=3000
2,4,6-Trinitrotoluene	5.0E-04	Medium	1	5.0E-04	--	Oral (dog)	Liver effects	UF=1000
2,6-Dinitrotoluene	1.0E-03	Medium	1	1.0E-03	--	Oral (dog)	Neurological, hematological, and liver histopathology	UF=3000
2-Methylnaphthalene	4.0E-03	Low	1	4.0E-03	--	Oral (mice)	Pulmonary alveolar proteinosis	(O) UF=1000
Dibenzofuran	4.0E-03	Low	1	4.0E-03	--	Oral (rat)	Lesion	UF=3000
Fluoranthene	4.0E-02	Low	0.58	4.0E-02	--	Oral (mice)	Nephropathy, increased weight, alterations and clinical effects	UF=3000
Fluorene	4.0E-02	Low	1	4.0E-02	--	Oral (mice)	Decreased RBC, packed cell volume and hemoglobin	UF=3000
Naphthalene	2.0E-02	Low	0.58	2.0E-02	8.6E-04	Oral (rat)	Decreased mean terminal body weights in males	UF=3000
Pyrene	3.0E-02	Low	0.58	3.0E-02	--	Oral (mice)	Renal effects	UF=3000

[a] % GI absorption values from USEPA 2004.
(O) indicates oral, (I) indicates inhalation.
RfD = Reference dose.
SGOT = Serum Glutamic-Oxaloacetic Transaminase.
USEPA = U. S. Environmental Protection Agency
UF = Uncertainty factor.
NA = Not available.
LDH = Lactic Acid Dehydrogenase.
-- = No value available.
GI =Gastrointestinal.
COPC = Constituent of potential concern.
RBC = Red blood cell.

Table 2-6. Cancer Slope Factors for COPCs

COPC	Oral Slope Factor (mg/kg-day)$^{-1}$	% GI absorption[a]	Dermal Slope Factor (mg/kg-day)$^{-1}$	Inhalation Slope Factor (mg/kg-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
2,6-Dinitrotoluene	6.8E-01	1	6.8E-01	--	B2	--	Liver carcinoma, mammary adenomas, fibromas (mouse)
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
Benzo(k)fluoranthene	7.3E-02	0.58	7.3E-02	3.1E-02	B2	0.01	Tumors (mouse)
Carbazole	2.0E-02	1	2.0E-02	--	B2	--	Liver tumors (mouse)
Chrysene	7.3E-03	0.58	7.3E-03	3.1E-03	B2	0	Carcinomas and malignant lymphoma (mouse)
Dibenz(a,h)anthracene	7.3E+00	0.58	7.3E+00	3.1E+00	B2	1	Immunodepressive effects (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.

COPC = Constituent of potential concern.

GI = Gastrointestinal.

USEPA = U. S. Environmental Protection Agency.

Table 22-7. RQL 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	733	733
$R_{fetal/maternal}$	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**	**3.2**	**2.7**
$PbB_{fetal, 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**7.5**	**8.1**
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**			**%**	**1.6%**	**2.7%**

[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 22-8. RQL Shallow Surface Soil (0-1 ft BGS) Calculations of Blood Lead Concentrations for Adult Trespasser

Exposure Variable	PbB Equation[1]				Adult Trespasser	
	1*	2*	Description of Exposure Variable	Units	GSDi = 1.8	GSDi = 2.1
PbS	X	X	Soil lead concentration	ug/g or mg/kg	733	733
$R_{fetal/maternal}$	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**	**2.9**	**2.4**
$PbB_{fetal, 0.95}$	**95th percentile PbB among fetuses of adult workers**			**ug/dL**	**6.9**	**7.4**
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**			**%**	**1.2%**	**2.0%**

[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 22-9. 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		
RQL									
Aluminum	1.5E+04	7.4E-04	7.2E-05	8.0E-08	7.4E-04	7.2E-05	5.6E-05	8.6E-04	
Antimony	4.1E+00	2.1E-07	2.0E-08	2.3E-11	5.2E-04	3.4E-04		8.7E-04	
Arsenic	1.5E+01	7.8E-07	2.3E-06	8.4E-11	2.6E-03	7.6E-03		1.0E-02	
Cadmium	2.1E+00	1.1E-07	1.0E-08	1.1E-11	1.1E-04	4.1E-04		5.2E-04	
Chromium	5.2E+01	2.6E-06	2.6E-07	2.9E-10	8.8E-04	3.4E-03	1.0E-05	4.3E-03	
Copper	9.4E+01	4.8E-06	4.6E-07	5.1E-10	1.2E-04	1.2E-05		1.3E-04	
Thallium	4.0E-01	2.0E-08	2.0E-09	2.2E-12	2.5E-04	2.5E-05		2.8E-04	
Vanadium	2.5E+01	1.3E-06	1.3E-07	1.4E-10	1.8E-04	6.9E-04		8.8E-04	
Inorganics Pathway Total					5.4E-03	1.3E-02	6.6E-05	1.8E-02	
1,3-Dinitrobenzene	7.8E-01	4.0E-08	3.9E-07	4.3E-12	4.0E-04	3.9E-03		4.3E-03	
2,4,6-Trinitrotoluene	8.0E-01	4.0E-08	3.9E-07	4.4E-12	8.1E-05	7.9E-04		8.7E-04	
2,6-Dinitrotoluene	1.6E+00	8.0E-08	7.8E-07	8.6E-12	8.0E-05	7.8E-04		8.6E-04	
2-Methylnaphthalene	1.2E+01	5.9E-07	5.8E-06	6.4E-11	1.5E-04	1.4E-03		1.6E-03	
Benz(a)anthracene	2.6E+02	1.3E-05	1.7E-04	1.4E-09					
Benzo(a)pyrene	1.8E+02	9.0E-06	1.1E-04	9.7E-10					
Benzo(b)fluoranthene	2.2E+02	1.1E-05	1.4E-04	1.2E-09					
Benzo(k)fluoranthene	1.1E+02	5.4E-06	6.9E-05	5.9E-10					
Carbazole	8.5E+01	4.3E-06	4.2E-05	4.7E-10					
Chrysene	1.9E+02	9.4E-06	1.2E-04	1.0E-09					
Dibenz(a,h)anthracene	3.3E+01	1.7E-06	2.2E-05	1.8E-10					
Dibenzofuran	5.0E+01	2.5E-06	2.5E-05	2.7E-10	6.3E-04	6.2E-03		6.8E-03	
Fluoranthene	5.7E+02	2.9E-05	3.7E-04	3.1E-09	7.3E-04	9.2E-03		9.9E-03	
Fluorene	8.3E+01	4.2E-06	4.1E-05	4.6E-10	1.1E-04	1.0E-03		1.1E-03	
Indeno(1,2,3-cd)pyrene	1.2E+02	5.9E-06	7.5E-05	6.4E-10					
Naphthalene	1.9E+01	9.5E-07	1.2E-05	1.0E-10	4.7E-05	6.0E-04	1.2E-07	6.5E-04	
Pyrene	5.5E+02	2.8E-05	3.6E-04	3.0E-09	9.4E-04	1.2E-02		1.3E-02	

Table 2-9. Juvenile Trespasser Shallow Surface Soil (0-1 ft BGS) Non-carcinogenic Hazards - Direct Contact (continued)

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		
Organics Pathway Total					3.2E-03	3.6E-02	1.2E-07	3.9E-02	
Pathway Total - Chemicals					8.5E-03	4.8E-02	6.6E-05	5.7E-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.
RQL = Ramsdell Quarry Landfill.

Table 22-10. 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		
RQL									
Aluminum	1.5E+04	1.1E-04	1.0E-05	1.1E-08					
Antimony	4.1E+00	3.0E-08	2.9E-09	3.2E-12					
Arsenic	1.5E+01	1.1E-07	3.3E-07	1.2E-11	1.7E-07	4.9E-07	1.8E-10	6.5E-07	
Cadmium	2.1E+00	1.5E-08	1.5E-09	1.6E-12			1.0E-11	1.0E-11	
Chromium	5.2E+01	3.8E-07	3.7E-08	4.1E-11			1.7E-09	1.7E-09	
Copper	9.4E+01	6.8E-07	6.6E-08	7.4E-11					
Thallium	4.0E-01	2.9E-09	2.8E-10	3.1E-13					
Vanadium	2.5E+01	1.8E-07	1.8E-08	2.0E-11					
Inorganics Pathway Total					1.7E-07	4.9E-07	1.9E-09	6.6E-07	
1,3-Dinitrobenzene	7.8E-01	5.7E-09	5.5E-08	6.1E-13					
2,4,6-Trinitrotoluene	8.0E-01	5.8E-09	5.6E-08	6.2E-13	1.7E-10	1.7E-09		1.9E-09	
2,6-Dinitrotoluene	1.6E+00	1.1E-08	1.1E-07	1.2E-12	7.7E-09	7.6E-08		8.3E-08	
2-Methylnaphthalene	1.2E+01	8.4E-08	8.2E-07	9.1E-12					
Benz(a)anthracene	2.6E+02	1.9E-06	2.4E-05	2.0E-10	1.4E-06	1.7E-05	6.3E-11	1.9E-05	R
Benzo(a)pyrene	1.8E+02	1.3E-06	1.6E-05	1.4E-10	9.4E-06	1.2E-04	4.3E-10	1.3E-04	R
Benzo(b)fluoranthene	2.2E+02	1.6E-06	2.0E-05	1.7E-10	1.2E-06	1.5E-05	5.4E-11	1.6E-05	R
Benzo(k)fluoranthene	1.1E+02	7.8E-07	9.9E-06	8.4E-11	5.7E-08	7.2E-07	2.6E-12	7.8E-07	
Carbazole	8.5E+01	6.2E-07	6.0E-06	6.7E-11	1.2E-08	1.2E-07		1.3E-07	
Chrysene	1.9E+02	1.3E-06	1.7E-05	1.5E-10	9.8E-09	1.2E-07	4.5E-13	1.3E-07	
Dibenz(a,h)anthracene	3.3E+01	2.4E-07	3.1E-06	2.6E-11	1.8E-06	2.2E-05	8.1E-11	2.4E-05	R
Dibenzofuran	5.0E+01	3.6E-07	3.5E-06	3.9E-11					
Fluoranthene	5.7E+02	4.1E-06	5.3E-05	4.5E-10					
Fluorene	8.3E+01	6.0E-07	5.9E-06	6.5E-11					
Indeno(1,2,3-cd)pyrene	1.2E+02	8.4E-07	1.1E-05	9.1E-11	6.1E-07	7.8E-06	2.8E-11	8.4E-06	R
Naphthalene	1.9E+01	1.4E-07	1.7E-06	1.5E-11					
Pyrene	5.5E+02	4.0E-06	5.1E-05	4.3E-10					

Table 2-10. Juvenile Trespasser Shallow Surface Soil (0-1 ft BGS) Carcinogenic Risks - Direct Contact (continued)

COPC	EPC (mg/kg)	Daily Intake (mg/kg-d)			Risk			Total Risk Across All Pathways	COC[a]
		Ingestion	Dermal	Inhalation	Ingestion	Dermal	Inhalation		
Organics Pathway Total					1.4E-05	1.8E-04	6.6E-10	2.0E-04	
Pathway Total - Chemicals					1.5E-05	1.8E-04	2.6E-09	2.0E-04	

[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.
RQL = Ramsdell Quarry Landfill.

Table 22-11. 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		
RQL									
Aluminum	1.5E+04	3.5E-04	9.7E-05	7.7E-08	3.5E-04	9.7E-05	5.4E-05	5.1E-04	
Antimony	4.1E+00	1.0E-07	2.8E-08	2.2E-11	2.5E-04	4.6E-04		7.1E-04	
Arsenic	1.5E+01	3.7E-07	3.1E-06	8.1E-11	1.2E-03	1.0E-02		1.1E-02	
Cadmium	2.1E+00	5.1E-08	1.4E-08	1.1E-11	5.1E-05	5.6E-04		6.1E-04	
Chromium	5.2E+01	1.3E-06	3.5E-07	2.8E-10	4.2E-04	4.6E-03	9.7E-06	5.1E-03	
Copper	9.4E+01	2.3E-06	6.3E-07	5.0E-10	5.7E-05	1.6E-05		7.3E-05	
Thallium	4.0E-01	9.7E-09	2.7E-09	2.1E-12	1.2E-04	3.3E-05		1.5E-04	
Vanadium	2.5E+01	6.2E-07	1.7E-07	1.3E-10	8.9E-05	9.3E-04		1.0E-03	
Inorganics Pathway Total					2.6E-03	1.7E-02	6.3E-05	2.0E-02	
1,3-Dinitrobenzene	7.8E-01	1.9E-08	5.2E-07	4.1E-12	1.9E-04	5.2E-03		5.4E-03	
2,4,6-Trinitrotoluene	8.0E-01	1.9E-08	5.3E-07	4.2E-12	3.9E-05	1.1E-03		1.1E-03	
2,6-Dinitrotoluene	1.6E+00	3.8E-08	1.1E-06	8.3E-12	3.8E-05	1.1E-03		1.1E-03	
2-Methylnaphthalene	1.2E+01	2.8E-07	7.8E-06	6.1E-11	7.1E-05	1.9E-03		2.0E-03	
Benz(a)anthracene	2.6E+02	6.3E-06	2.3E-04	1.4E-09					
Benzo(a)pyrene	1.8E+02	4.3E-06	1.5E-04	9.4E-10					
Benzo(b)fluoranthene	2.2E+02	5.4E-06	1.9E-04	1.2E-09					
Benzo(k)fluoranthene	1.1E+02	2.6E-06	9.3E-05	5.7E-10					
Carbazole	8.5E+01	2.1E-06	5.7E-05	4.5E-10					
Chrysene	1.9E+02	4.5E-06	1.6E-04	9.8E-10					
Dibenz(a,h)anthracene	3.3E+01	8.2E-07	2.9E-05	1.8E-10					
Dibenzofuran	5.0E+01	1.2E-06	3.3E-05	2.6E-10	3.1E-04	8.4E-03		8.7E-03	
Fluoranthene	5.7E+02	1.4E-05	5.0E-04	3.0E-09	3.5E-04	1.2E-02		1.3E-02	
Fluorene	8.3E+01	2.0E-06	5.6E-05	4.4E-10	5.1E-05	1.4E-03		1.4E-03	
Indeno(1,2,3-cd)pyrene	1.2E+02	2.8E-06	1.0E-04	6.1E-10					

Table 22-12. 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		
Naphthalene	1.9E+01	4.6E-07	1.6E-05	9.9E-11	2.3E-05	8.1E-04	1.2E-07	8.4E-04	
Pyrene	5.5E+02	1.4E-05	4.8E-04	2.9E-09	4.5E-04	1.6E-02		1.7E-02	
Organics Pathway Total					1.5E-03	4.8E-02	1.2E-07	5.0E-02	
Pathway Total - Chemicals					4.1E-03	6.5E-02	6.4E-05	7.0E-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.
RQL = Ramsdell Quarry Landfill.

Table 22-13. Adult Trespasser Shallow Surface Soil (0-1 ft BGS) Carcinogenic Risks - 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		
RQL									
Aluminum	1.9E+04	9.6E-04	9.4E-05	1.0E-07	9.6E-04	9.4E-05	7.3E-05	1.1E-03	
Arsenic	3.3E+01	1.6E-06	4.8E-06	1.8E-10	5.5E-03	1.6E-02		2.2E-02	
Cadmium	6.4E+00	3.2E-07	3.2E-08	3.5E-11	3.2E-04	1.3E-03		1.6E-03	
Chromium	3.1E+01	1.6E-06	1.5E-07	1.7E-10	5.2E-04	2.0E-03	5.9E-06	2.6E-03	
Manganese	2.2E+03	1.1E-04	1.1E-05	1.2E-08	2.4E-03	5.9E-03	8.5E-04	9.2E-03	
Thallium	1.5E+00	7.7E-08	7.5E-09	8.4E-12	9.6E-04	9.4E-05		1.1E-03	
Vanadium	3.5E+01	1.8E-06	1.7E-07	1.9E-10	2.5E-04	9.5E-04		1.2E-03	
Inorganics Pathway Total					1.1E-02	2.7E-02	9.2E-04	3.8E-02	
Benzo(a)pyrene	3.4E-01	1.7E-08	2.2E-07	1.9E-12					
Organics Pathway Total									
Pathway Total - Chemicals					1.1E-02	2.7E-02	9.2E-04	3.8E-02	

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

Table 22-14. 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		
RQL									
Aluminum	1.9E+04	1.4E-04	1.3E-05	1.5E-08					
Arsenic	3.3E+01	2.4E-07	6.9E-07	2.6E-11	3.5E-07	1.0E-06	3.8E-10	1.4E-06	R
Cadmium	6.4E+00	4.6E-08	4.5E-09	5.0E-12			3.2E-11	3.2E-11	
Chromium	3.1E+01	2.2E-07	2.2E-08	2.4E-11			1.0E-09	1.0E-09	
Manganese	2.2E+03	1.6E-05	1.6E-06	1.7E-09					
Thallium	1.5E+00	1.1E-08	1.1E-09	1.2E-12					
Vanadium	3.5E+01	2.5E-07	2.5E-08	2.7E-11					
Inorganics Pathway Total					3.5E-07	1.0E-06	1.4E-09	1.4E-06	
Benzo(a)pyrene	3.4E-01	2.5E-09	3.1E-08	2.7E-13	1.8E-08	2.3E-07	8.3E-13	2.5E-07	
Organics Pathway Total					1.8E-08	2.3E-07	8.3E-13	2.5E-07	
Pathway Total - Chemicals					3.7E-07	1.3E-06	1.4E-09	1.6E-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.
RQL = Ramsdell Quarry Landfill.

Table 22-15. 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		
RQL									
Aluminum	1.9E+04	4.6E-04	1.3E-04	1.0E-07	4.6E-04	1.3E-04	7.0E-05	6.6E-04	
Arsenic	3.3E+01	8.0E-07	6.5E-06	1.7E-10	2.7E-03	2.2E-02		2.4E-02	
Cadmium	6.4E+00	1.6E-07	4.3E-08	3.4E-11	1.6E-04	1.7E-03		1.9E-03	
Chromium	3.1E+01	7.6E-07	2.1E-07	1.6E-10	2.5E-04	2.8E-03	5.7E-06	3.0E-03	
Manganese	2.2E+03	5.4E-05	1.5E-05	1.2E-08	1.2E-03	8.0E-03	8.2E-04	1.0E-02	
Thallium	1.5E+00	3.7E-08	1.0E-08	8.1E-12	4.6E-04	1.3E-04		5.9E-04	
Vanadium	3.5E+01	8.6E-07	2.3E-07	1.9E-10	1.2E-04	1.3E-03		1.4E-03	
Inorganics Pathway Total					5.3E-03	3.6E-02	8.9E-04	4.2E-02	
Benzo(a)pyrene	3.4E-01	8.3E-09	3.0E-07	1.8E-12					
Organics Pathway Total									
Pathway Total - Chemicals					5.3E-03	3.6E-02	8.9E-04	4.2E-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.
RQL = Ramsdell Quarry Landfill.

Table 22-16. 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		
RQL									
Aluminum	1.9E+04	2.0E-04	5.4E-05	4.3E-08					
Arsenic	3.3E+01	3.4E-07	2.8E-06	7.4E-11	5.1E-07	4.2E-06	1.1E-09	4.7E-06	R
Cadmium	6.4E+00	6.7E-08	1.8E-08	1.5E-11			9.2E-11	9.2E-11	
Chromium	3.1E+01	3.2E-07	8.9E-08	7.0E-11			2.9E-09	2.9E-09	
Manganese	2.2E+03	2.3E-05	6.3E-06	5.0E-09					
Thallium	1.5E+00	1.6E-08	4.4E-09	3.5E-12					
Vanadium	3.5E+01	3.7E-07	1.0E-07	7.9E-11					
Inorganics Pathway Total					5.1E-07	4.2E-06	4.1E-09	4.7E-06	
Benzo(a)pyrene	3.4E-01	3.6E-09	1.3E-07	7.7E-13	2.6E-08	9.3E-07	2.4E-12	9.5E-07	
Organics Pathway Total					2.6E-08	9.3E-07	2.4E-12	9.5E-07	
Pathway Total - Chemicals					5.4E-07	5.1E-06	4.2E-09	5.7E-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 22-17. 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		
RQL							
Aluminum	5.0E+01	1.5E-02	5.3E-03	1.5E-02	5.3E-03	2.0E-02	
Arsenic	2.2E-02	6.7E-06	2.1E-06	2.2E-02	7.1E-03	2.9E-02	
Manganese	5.6E+00	1.7E-03	3.6E-04	3.7E-02	1.9E-01	2.3E-01	
Vanadium	4.7E-02	1.4E-05	3.2E-06	2.1E-03	1.7E-02	1.9E-02	
Inorganics Pathway Total				7.7E-02	2.2E-01	3.0E-01	
Aldrin	1.2E-05	3.7E-09	2.8E-07	1.2E-04	9.3E-03	9.4E-03	
Methylene chloride	5.5E-03	1.7E-06	1.2E-06	2.8E-05	2.0E-05	4.8E-05	
Tetrachloroethene	6.0E-04	1.8E-07	1.4E-06	1.8E-05	1.4E-04	1.6E-04	
Organics Pathway Total				1.7E-04	9.4E-03	9.6E-03	
Pathway Total - Chemicals				7.7E-02	2.3E-01	3.1E-01	

[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.
RQL = Ramsdell Quarry Landfill.

Table 22-18. 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		
RQL							
Aluminum	5.0E+01	2.2E-03	7.5E-04				
Arsenic	2.2E-02	9.6E-07	3.0E-07	1.4E-06	4.5E-07	1.9E-06	R
Manganese	5.6E+00	2.4E-04	5.1E-05				
Vanadium	4.7E-02	2.1E-06	4.5E-07				
Inorganics Pathway Total				1.4E-06	4.5E-07	1.9E-06	
Aldrin	1.2E-05	5.2E-10	4.0E-08	8.9E-09	6.8E-07	6.8E-07	
Methylene chloride	5.5E-03	2.4E-07	1.7E-07	1.8E-09	1.3E-09	3.1E-09	
Tetrachloroethene	6.0E-04	2.6E-08	2.0E-07	1.4E-09	1.1E-08	1.2E-08	
Organics Pathway Total				1.2E-08	6.9E-07	7.0E-07	
Pathway Total – Chemicals				1.5E-06	1.1E-06	2.6E-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.
RQL = Ramsdell Quarry Landfill.

Table 22-19. 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		
RQL									
Aluminum	5.0E+01	1.5E-02	3.6E-03		1.5E-02	3.6E-03		1.8E-02	
Arsenic	2.2E-02	6.5E-06	1.4E-06		2.2E-02	4.8E-03		2.6E-02	
Manganese	5.6E+00	1.6E-03	2.4E-04		3.6E-02	1.3E-01		1.7E-01	
Vanadium	4.7E-02	1.4E-05	2.1E-06		2.0E-03	1.2E-02		1.4E-02	
Inorganics Pathway Total					7.4E-02	1.5E-01		2.2E-01	
Aldrin	1.2E-05	3.5E-09	1.9E-07		1.2E-04	6.3E-03		6.4E-03	
Methylene chloride	5.5E-03	1.6E-06	8.2E-07		2.7E-05	1.4E-05		4.1E-05	
Tetrachloroethene	6.0E-04	1.8E-07	9.7E-07		1.8E-05	9.7E-05		1.1E-04	
Organics Pathway Total					1.6E-04	6.4E-03		6.5E-03	
Pathway Total - Chemicals					7.4E-02	1.6E-01		2.3E-01	

[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.
RQL = Ramsdell Quarry Landfill.

Table 22-20. 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		
RQL									
Aluminum	5.0E+01	6.2E-03	1.5E-03						
Arsenic	2.2E-02	2.8E-06	6.1E-07		4.2E-06	9.2E-07		5.1E-06	R
Manganese	5.6E+00	7.1E-04	1.0E-04						
Vanadium	4.7E-02	5.9E-06	9.1E-07						
Inorganics Pathway Total					4.2E-06	9.2E-07		5.1E-06	
Aldrin	1.2E-05	1.5E-09	8.0E-08		2.6E-08	1.4E-06		1.4E-06	R
Methylene chloride	5.5E-03	6.9E-07	3.5E-07		5.2E-09	2.6E-09		7.9E-09	
Tetrachloroethene	6.0E-04	7.5E-08	4.1E-07		3.9E-09	2.2E-08		2.5E-08	
Organics Pathway Total					3.5E-08	1.4E-06		1.4E-06	
Pathway Total - Chemicals					4.2E-06	2.3E-06		6.5E-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.
HI = Hazard index.
RQL = Ramsdell Quarry Landfill.

Appendix 3A
Fate and Transport of COCs in Soil

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3A.0 CONTAMINANT FATE AND TRANSPORT

3A.1 INTRODUCTION

An assessment of impacted soils at RQL was conducted to evaluate their potential to impact groundwater both at the AOC (residential land use exposure scenario) and at an exposure point downgradient of the AOC (Security Guard/Maintenance Worker land use exposure scenario) to ensure residual concentrations in soils are protective of groundwater under both potential land use exposure scenarios. The process for identifying these soil constituents with potential to impact groundwater is explained and executed in Section 3A.2. Section 3A.3 presents the conclusion of the evaluation: a list of AOC-specific constituents producing unacceptable impact to groundwater beneath the source (affecting residential land usage) or at a receptor downgradient of the source (affecting restricted land usage).

3A.2 EVALUATION

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

- Section 3A.2.1 lists constituents identified in the RI Report as potentially impacting groundwater.
- Section 3A.2.2 evaluates these constituents across multiple media to further refine the list of potential constituents.
- Section 3A.2.3 presents refinements to the modeling performed in the RI Report, if appropriate.

3A.2.1 RI Evaluation Process

Constituents are identified in Chapter 5 (Contaminant Fate and Transport) of the RI Report that potentially impact groundwater at RQL. 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 CMCOPC. 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 PRG. Constituents also are identified as CMCOPCs if they were detected in AOC groundwater and exceeded the MCL or 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.

3A.2.2 AOC-Specific Evaluation

The constituents identified in Table 3A-1 are evaluated across multiple media. The evaluation examines the constituent distribution in soil or water compared to background concentrations. It also examines the nature of modeling completed during the RI. The criteria below were evaluated to determine the potential for impacts to groundwater from impacted soils at RQL.

Background: If model input source concentrations are less than either surface (0-1 ft BGS) or subsurface (1-3 ft BGS) background, predicted results are compared to observed groundwater data to assess the generally conservative nature of the modeling. 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 pattern of detection (e.g. do elevated surface and subsurface soil results occur at the same location; is there a pattern of detections indicative of a contaminant plume; are the elevated detections located in separate areas with no recognizable pattern).

Predicted Time of Maximum Impact: If the predicted time of maximum impact in RI is short (e.g., less than 10 years) and activities ceased at the AOC long before that period of time, the predicted maximum impact has likely occurred in the past. In these cases, observed groundwater data are reviewed, and if maximum observed groundwater data 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, the constituent is removed from further consideration of future groundwater impacts.

Detected in Groundwater: If a constituent is detected in groundwater, but not detected in soils, the constituent is removed from further consideration of future groundwater impacts. If a constituent is detected in groundwater and is detected in soils at or below background levels, the constituent also is removed from further consideration of future groundwater impacts.

3A.2.2.1 Ramsdell Quarry Landfill

Based on the results of the Phase I RI for the RQL, nine constituents are evaluated for potential impacts in groundwater beneath the source and three constituents are evaluated for potential impacts to groundwater at downgradient receptors (Table 3A-1). Upon further analysis, none of these constituents were predicted or identified to impact groundwater at the AOC or downgradient of the AOC as summarized below.

Table 3A-1. Potential Groundwater Impacts Identified in Phase I RI for RQL

Potential Groundwater Impact Beneath the Source[a]	Potential Groundwater Impact Downgradient of the Source[b]
Ramsdell Quarry Landfill	
Antimony	
Arsenic	
Chromium (total)	
Manganese	
1,3-Dinitrobenzene	
2,6-Dinitrotoluene	
Nitroglycerin	Nitroglycerin
RDX	RDX
Carbazole	Carbazole

[a]Potential groundwater impact beneath the source is determined from either SESOIL+AT123D modeling in the RI of the concentration at the water table or observed MCL/PRG exceedance of groundwater samples identified in the RI.
[b]Potential groundwater impact downgradient of the source is determined from AT123D modeling of the plume migrating to receptors.
AT123D = Analytical Transient 1-,2-,3- Dimensional.
MCL = Maximum contaminant level.
PRG = U. S. Environmental Protection Agency Region 9 preliminary remediation goal.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RI = Remedial Investigation.
SESOIL = Seasonal Soil Compartment Model.

- Antimony is removed from further consideration of future groundwater impacts at RQL because there are no detections in surface water or groundwater in excess of the MCL from impacted soils that are in periodic contact with surface water/groundwater.

- Arsenic is removed from further consideration of future groundwater impacts because there is only a single exceedance of background; both the source concentration and the EPC at RQL are less than subsurface soil background; and observed groundwater results are below the MCL. Modeling results indicate background levels of arsenic in soils may result in groundwater impacts in excess of the MCL.

- Detected concentrations of chromium occur near the groundwater surface and adjacent to surface water, yet groundwater and surface water detectable concentrations are well below the MCL. SESOIL modeling completed in the RI used a concentration of 37.2 mg/kg for the entire source area. Only one sample exceeded this value with all remaining sample concentrations less than 37.2 mg/kg. Multi-increment sample results for chromium are similar to subsurface and surface soil background and less than 37.2 mg/kg. The conservative nature of the modeling and the observed groundwater and surface water sample results indicate concentrations in soils will not contribute to groundwater impacts in excess of the MCL. Therefore, chromium is removed form further consideration of future groundwater impacts.

- All detections of manganese in soil samples were below background values; therefore manganese is removed from further consideration of future groundwater impacts.

- 1,3-DNB: RI SESOIL source load modeling predicted maximum impact in 2 years. Given AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. 1,3-DNB is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 2 years (so maximum impact has likely passed), and the observed groundwater levels are well below the MCL.

- 2,6-DNT: RI SESOIL source load modeling predicted maximum impact in 3 years. Given AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. 2,6-DNT is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 3 years, and 2,6-DNT has not been detected in either surface water or groundwater.

- Nitroglycerin: RI SESOIL source load modeling predicted maximum impact in 6 years. Given AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. Nitroglycerin is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 6 years (so maximum impact has likely passed), and nitroglycerin has not been detected in surface water or recent groundwater samples (2003-2004) at RQL.

- RDX: RI SESOIL source load modeling predicted maximum impact in 2 years. Given AOC history, the maximum impact likely occurred in the past, and predicted future impacts are expected to decline over time. RDX is removed from further consideration of future groundwater impacts at RQL because there is only a single detection in soils, the predicted time of maximum impact to groundwater is 2 years (so maximum impact has likely passed), and RDX has not been detected in surface water or recent groundwater samples (2003-2004) at RQL.

- Carbazole is removed from further consideration of future groundwater impacts at RQL because there are no detections in surface water or groundwater from impacted soils that are in periodic contact with surface water/groundwater.

3A.2.3 Refined AOC-Specific Modeling Results

Based on analyses of the conservative fate and transport assessment performed in support of the RI for RQL, no COCs were identified for further analysis using the SESOIL/AT123D models previously developed with refined input parameters.

3A.3 CONCLUSIONS

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

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Appendix 3B
Volume Estimates

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3B.0 VOLUME ESTIMATES

3B.1 INTRODUCTION

This appendix presents the methodology, data, and information used to estimate the volume of impacted soils and/or dry sediments at RQL for preliminary cleanup goals based on the restricted (Security Guard/Maintenance Worker) or the residential (Resident Subsistence Farmer) land use exposure scenarios. The volume of impacted soils and dry sediments is driven by the COCs and preliminary cleanup goals identified in Chapter 3 of this FS.

3B.2 ENVIRONMENTAL DATA

Chapter 3 of this FS Report details the impacted media and the associated COCs and preliminary cleanup goals identified for RQL. Table 3B.1 summarizes the COCs and preliminary cleanup goals modeled to generate estimated volumes of impacted soils and/or dry sediments at RQL where COCs in these media were identified to be evaluated further in the FS.

The predominant source of data for developing the volume estimate at RQL was the RI Report. Analytical data from these investigations defined the nature and extent of contamination at this AOC and were used to determine extents for specific COCs.

Table 3B-1. Modeled COCs and Preliminary Cleanup Goals

Media	Constituent of Concern	EPC (mg/kg)	Preliminary Cleanup Goals (mg/kg)
RQL ~ Security Guard/Maintenance Worker Land Use			
Soil	Benz(a)anthracene	259	13
	Benzo(a)pyrene	177	1.3
	Benzo(b)fluoranthene	222	13
	Dibenz(a,h)anthracene	33	1.3
	Indeno(1,2,3-cd)pyrene	116	13
RQL ~ Resident Subsistence Farmer Land Use			
Soil	Lead	733	400
	Benz(a)anthracene	259	5.9
	Benzo(a)pyrene	177	0.59
	Benzo(b)fluoranthene	222	5.9
	Benzo(k)fluoranthene	107	59
	Dibenz(a,h)anthracene	33.4	0.59
	Indeno(1,2,3-cd)pyrene	116	5.9

EPC = Exposure point concentration.
RQL = Ramsdell Quarry Landfill.

3B.3 MODELING

Environmental data (i.e., analytical data) were used to develop 3D models of the COCs in soils and/or dry sediments using EarthVision™ Version 7.99. The 3D modeling process can be viewed as expanding traditional 2D contouring programs into three dimensions. Environmental data at RQL were collected at various locations and depths. Concentrations are contoured at user-specified levels in 3D space. Volumes of soils and dry sediments above preliminary cleanup goals are subsequently calculated from the model.

Conceptual AOC knowledge is incorporated into the model to permit a more accurate representation of contaminant extent and volume estimates. Pertinent AOC features such as topography, water table elevations, top of bedrock elevations, etc., have been incorporated into the model to establish the upper and lower extents and to determine the volume of impacted soils and dry sediments. The locations of ditches and ponds are accounted for within the model.

There are a number of assumptions inherent in the development of the impacted soil and dry sediment volume estimates of COCs:

- Environmental data accurately represent the nature and extent of the COCs in soils and sediments at the AOC (i.e., significant contamination was detected during RI sampling activities).

- AOC knowledge (reported or observed) pertaining to the extent of the ditches, ponds, etc. permits an accurate representation of these features in the three-dimensional models.

- The impact of constructability is equal to 25% of the calculated in situ volume.

- The increase in volume (swell factor) is equal to 20% of the calculated constructability volume. One in situ or in place cubic yard is therefore equal to 1.2 yd^3 after excavation or ex situ.

3B.3.1.1 <u>Historical Information and AOC Knowledge</u>

Historical information summarized in the RI Reports provided additional information regarding potential contaminant distribution which was not captured in analytical data sources.

3B.3.1.2 <u>Over-Excavation and Constructability</u>

Excavation will be performed in a conservative manner to ensure preliminary cleanup goals are achieved. Additional excavated volume to assure safe slopes on side walls and to address machinery limitations (i.e., constructability) is estimated, as well as the effects of over-excavation and constructability. Experience in excavation has shown that this conservatism results in an over-excavation and constructability of roughly 25% of the estimated in situ volume.

3B.3.1.3 Ex Situ Volume

The volumes presented to this point constitute "in place" or in situ volumes. The act of excavation results in an expansion of the excavated material. This expanded volume is then transported and disposed. The volume expansion, or "swell", experienced by soil/sediment when it is excavated averages approximately 20% resulting in the overall estimated ex situ volume.

3B.4 ESTIMATED VOLUMES OF IMPACTED SOILS/DRY SEDIMENTS AT RQL

The estimated soil/dry sediment volumes developed for RQL, as described in Section 3B.3, are summarized in Table 3B.2.

3B.4.1 Ramsdell Quarry Landfill ~ Security Guard/Maintenance Worker Land Use

For the Security Guard/Maintenance Worker land use scenario at RQL, two soil samples (RQL-025 and RQL-026) are the primary locations which exceeded the preliminary cleanup goal for the following COCs:

- Benz(a)anthracene;
- Benzo(a)pyrene;
- Benzo(b)fluoranthene;
- Dibenz(a,h)anthracene; and
- Indeno(1,2,3,cd)pyrene.

For the restricted land use scenario, 282 yd^3 (in situ) of impacted soils is estimated. Figure 3B-1 depicts the modeled extent of impacted soils at RQL for restricted land use.

3B.4.2 Ramsdell Quarry Landfill ~ Resident Subsistence Farmer Land Use

For the residential land use scenario at RQL, four soil samples (RQL-025, RQL-026, RQL-028, and RQL-033) are the primary locations which exceeded the preliminary cleanup goal for the following COCs:

- Lead
- Benz(a)anthracene;
- Benzo(a)pyrene;
- Benzo(b)fluoranthene;
- Benzo(k)fluoranthene;
- Dibenz(a,h)anthracene; and
- Indeno(1,2,3,cd)pyrene.

For the residential land use scenario, 543 cubic yards (in situ) of impacted soils is estimated. Figure 3B-2 depicts the modeled extent of impacted soils at RQL for residential land use.

Table 3B-2. Estimated Volumes of Impacted Soils/Sediments

AOC/Scenario	Surface Area (ft^2)	In situ		In situ with Constructability[a]		Ex situ[a,b]	
		Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)	Volume (ft^3)	Volume (yd^3)
RQL Security Guard/Maintenance Worker Land Use – Soil	7,621	7,621	282	9,526	353	11,432	423
RQL Resident Subsistence Farmer Land Use – Soil	14,683	14,683	543	18,354	679	22,025	815

[a] Includes 25% constructability factor.
[b] Includes 20% swell factor.
AOC = Area of concern.
RQL = Ramsdell Quarry Landfill.

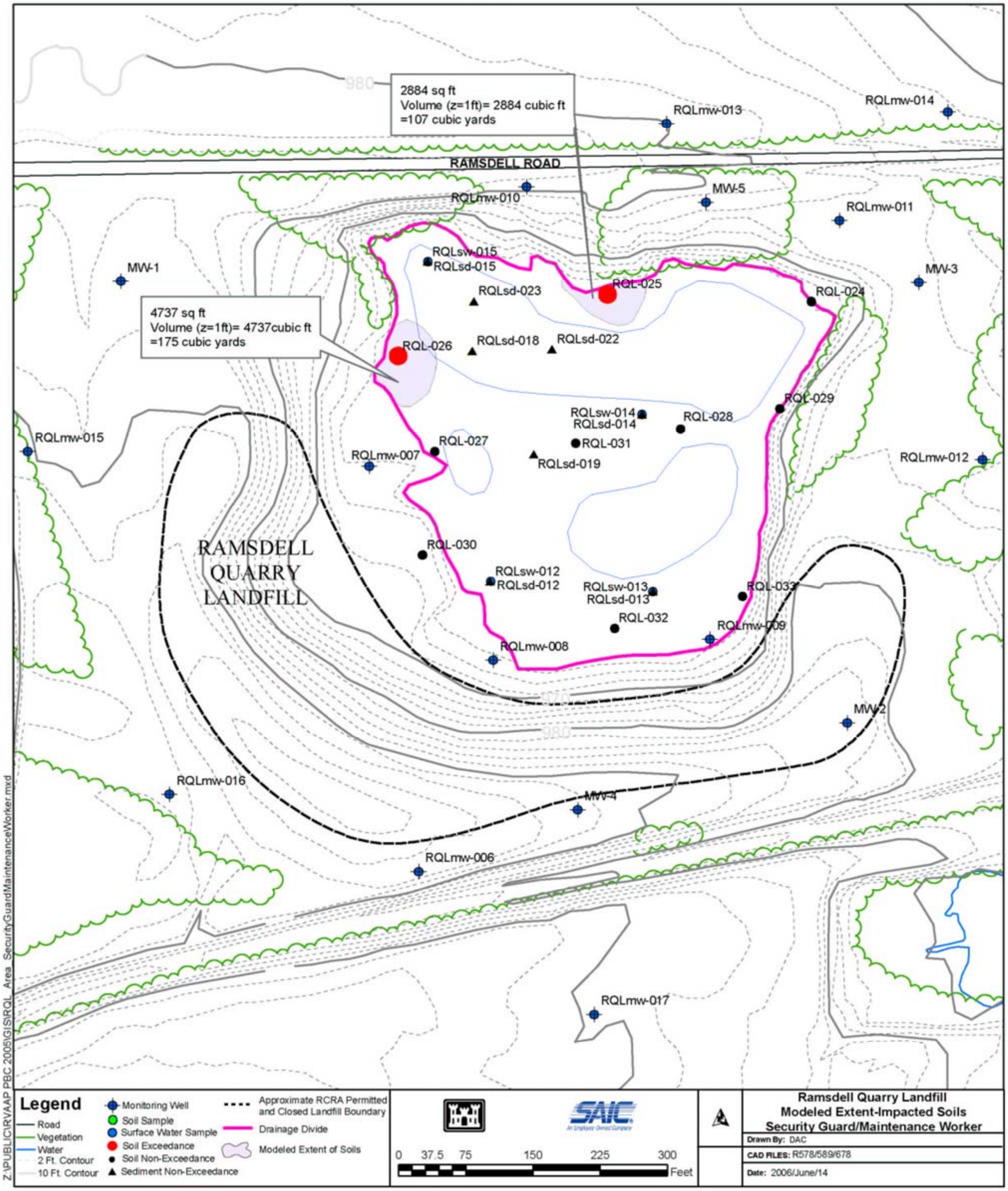

Figure 3B-1. Modeled Extent at Ramsdell Quarry Landfill – Security Guard/Maintenance Worker Land Use

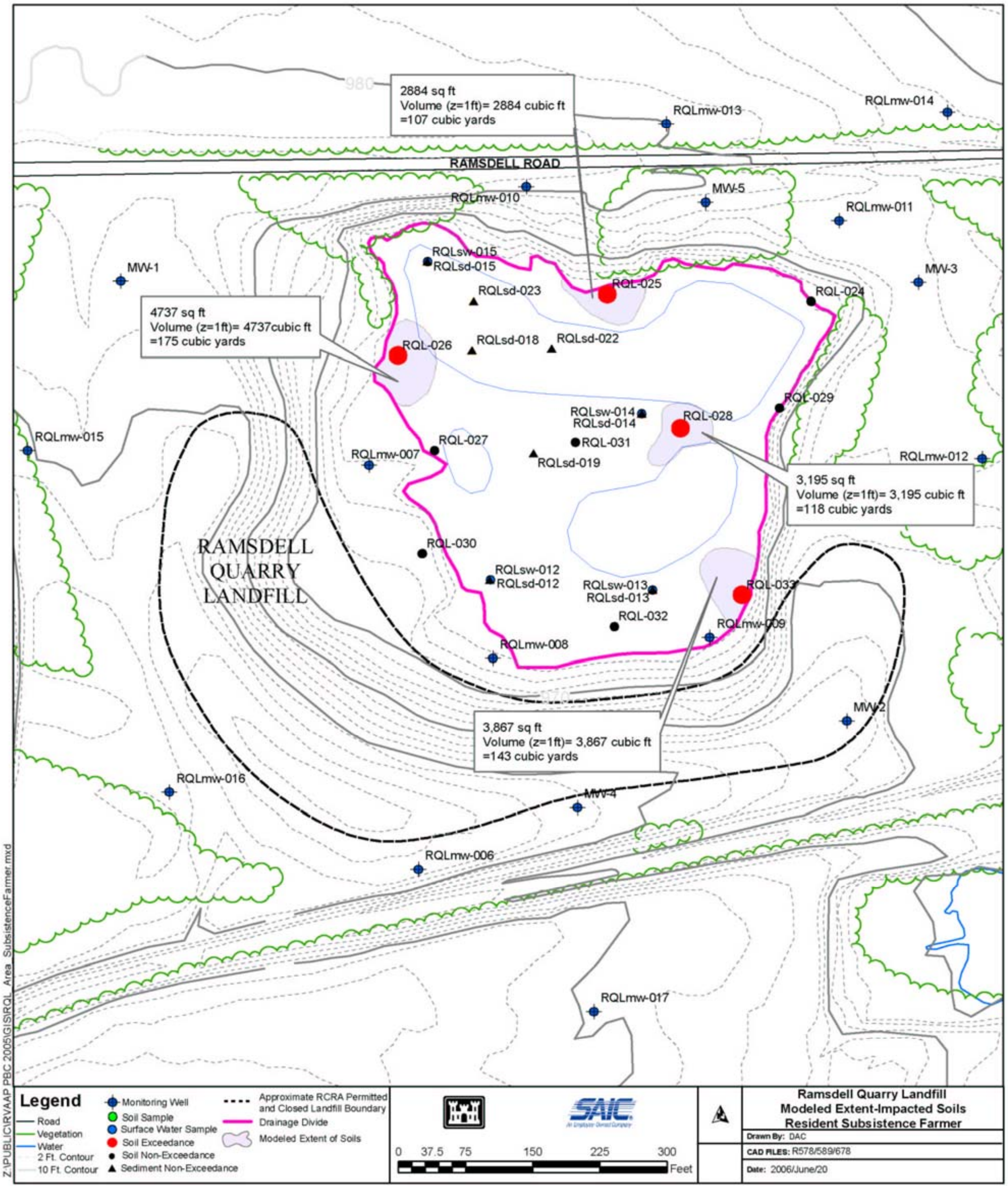

Figure 3B-2. Modeled Extent at Ramsdell Quarry Landfill – Resident Subsistence Farmer Land Use

Appendix 7
Detailed Cost Estimate

Feasibility Study for Six High Priority AOCs

Ramsdell Quarry Landfill - Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio

Summary of Alternatives

Ramsdell Quarry Landfill Alternatives		Duration	Non Discounted Cost		
			Soils and Sediment		
			Capital Cost	O&M Cost	Total
1	No Action	0	$0	$0	$0
2	Limited Action	30 yr	$19,527	$218,159	$237,686
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker	30 yr	$137,559	$218,159	$355,718
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$215,465	$0	$215,465

Ramsdell Quarry Landfill Alternatives		Duration	Discounted Cost (3.1%)		
			Soils and Sediment		
			Capital Cost	O&M Cost	Total
1	No Action	0	$0	$0	$0
2	Limited Action	30 yr	$19,527	$164,419	$183,946
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker	30 yr	$137,559	$164,419	$301,978
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$215,465	$0	$215,465

Notes:

1. The base year of comparison and cost data will be CY2005. The "real" discounted rates used to calculate present values will be based on OMB Circular No. A-94 memorandum dated January 31, 2005.

2. Costs were estimated for comparison purposes only and are believed to be accurate within a range of -30% to +50%. Use of these costs for other purposes, including but not limited to, budgetary or construction cost estimating is not appropriate.

Feasibility Study for Six High Priority AOCs
Ramsdell Quarry Landfill - Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
Summary of AOC Areas and Volumes

	Alternatives	Surface Area (sq ft)	*In situ*		*In situ with Constructability* [a]		*Ex situ* [a,b]		Total Volume (cy)
			Soil (cy)	Sediment (cy)	Soil (cy)	Sediment (cy)	Soil (cy)	Sediment (cy)	
1	No Action		Not Applicable						
2	Limited Action	7,621	Not Applicable						
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker	7,621	282	0	353	0	423	0	423
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	14,700	543	0	679	0	815	0	815

[a] Includes 25% constructability factor
[b] Includes 20% swell factor

Ramsdell Quarry Landfill Soil and Sediment
Alternative 2 - Limited Action
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Land Use Controls			
Base Master Planning Documents	hrs	80	Assume 80 hrs to review and revise BMP documents.
Legal/Technical Labor	$/hr	80	
Site Work			
Site Area	sf	7,621	
Civil Survey	day	1.0	Survey AOC areas and set monuments. RSMeans 01107 700 1200.
Civil Survey	$/day	885	
Civil Survey Monuments	ea	4	Assume 4 monuments around perimeter of AOC. RSMeans 01107 700 0600.
Civil Survey Monuments	$/ea	162	
As Built Drawings	hours	8	Develop plat map for incorporation into the Base Master Plan.
As Built Drawings	$/hr	60	
Install Signs on Posts	ea	4	Assume warning signs located around AOC perimeter at 100 ft centers. RSMeans 028907000100 & 1500. Add 50% for custom letters. Furnish, place, and install.
Install Signs on Posts	$/ea	185.25	
Plans and Reports			
Corrective Action Completion Report	hrs	40	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	
O&M Cost (Years 0 to 30)			
Sampling & Analysis	events	5	
Sampling & Analysis	years	5	Includes annual sampling for first 5 years. There are 5 total events. Assume 4 existing wells will be sampled and 3 soil/sediment samples collected in 1 day plus 1 day travel. Assumes 2 sampling technicians at 10 hours/day. Samples will be collected and analyzed for metals.
Annual Sampling Labor	days/event	2	
Annual Sampling Labor	hrs/event	40	
Annual Sampling Labor	$/hr	55	
Annual Per Diem	$/event	460	2 people x $115/day
Annual Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Sample materials	ea/event	18	Reference ECHOS 33 02 0401/0402 for disposable sampling and decon materials.
Sample materials	$/ea	21	
Annual Sample equipment	$/event	1,500	Water quality parameter equipment, pumps, misc tools, drums, and sampling equipment rental. Based on RACER model.
Analytical Cost	$/event	2,880	Analyze samples from 4 wells for metals (6 @ 100) and SVOCs (6 @ 220). Analyze 3 soil samples for metals (3 @ 100) and SVOCs (3 @ 220). Includes 10% duplicate and 5% rinsate.
Sample Shipment	$/event	100	2 coolers @ $50 ea.
Data Management	hrs	18	Data validation
Data Management	$/hr	60	
IDW Water Disposal	$/lot	700	Includes labor and travel to return IDW water to site after analysis.

Ramsdell Quarry Landfill Soil and Sediment
Alternative 2 - Limited Action
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
O&M Cost (Continued)			
Site Inspection and Maintenance	years	30	
Site Inspection	events	60	
Site Inspections	hrs	4	Inspect site semi-annually for disturbance/erosion, warning signs, and complete checklist for annual report.
Field Labor	$/hr	60	
Site Maintenance	events	30	Assume signs are replaced every 10 years. Assume AOC area is overseeded and fertilized every 5 years. Costs have been annualized.
Site Maintenance	$/yr	200	
Annual O&M Report			
Sampling and Analysis Reports	event	5	
Sampling and Analysis Reports	$/event	2,800	Assume 40 hours @ $70/hr for report.
Annual O&M Report	event	30	
Annual O&M Report	$/year	560	Assume 8 hours @ $70/hr for letter report.
CERCLA Reviews			
CERCLA 5-Year Reviews	events	6	Assume 5 year reviews for 30 years.
CERCLA 5-Year Reviews	$/event	6,600	Assume 80 hours/review @ $70/hr. Add $1,000 misc expenses.

Ramsdell Quarry Landfill Soil and Sediment
Alternative 2 - Limited Action
Cost Estimate

CAPITAL COST **$19,527**

Activity (unit)	Quantity	Unit Cost	Total
Land Use Controls			
Base Master Planning Documents (hr)	80	$80.00	$6,400
Site Work			
Civil Survey (day)	1	$885.00	$885
Civil Survey Monuments (ea)	4	$162.00	$648
As Built Drawings (hrs)	8	$60.00	$480
Install Signs on Posts (ea)	4	$185.25	$741
Plans and Reports			
Corrective Action Completion Report (ea)	40	$70.00	$2,800
Subtotal			$11,954
Design		15%	$1,793
Office Overhead		5%	$598
Field Overhead		15%	$1,793
Subtotal			$16,138
Profit		6%	$968
Contingency		15%	$2,421
Total			$19,527

Ramsdell Quarry Landfill Soil and Sediment
Alternative 2 - Limited Action
Cost Estimate

OPERATION AND MAINTENANCE	$218,159

Activity (unit)	Quantity	Unit Cost	Total Cost	Present Value (3.1%)
O&M Sampling & Analysis				
Sampling Labor (events)	5	$2,200	$11,000	$10,047
Per Diem (events)	5	$460	$2,300	$2,101
Cargo Van Rental / Gas (events)	5	$280	$1,400	$1,279
Sample materials (events)	5	$378	$1,890	$1,726
Sample equipment (events)	5	$1,500	$7,500	$6,850
Analytical Cost (events)	5	$2,880	$14,400	$13,152
Sample Shipment (events)	5	$100	$500	$457
Data Management (events)	5	$1,080	$5,400	$4,932
IDW Water Disposal (events)	5	$700	$3,500	$3,197
Site Inspection and Maintenance				
Site Inspection (ea)	60	$240	$14,400	$9,288
Site Maintenance (ea)	30	$200	$6,000	$3,870
Annual O&M Report				
Sampling and Analysis Reports (ea)	5	$2,800	$14,000	$12,787
Annual O&M Report (ea)	30	$560	$16,800	$10,836
CERCLA Reviews				
CERCLA 5-Year Reviews (ea)	6	$6,600	$39,600	$24,006
Subtotal O&M			$138,690	$104,526
Design		10%	$13,869	$10,453
Office Overhead		5%	$6,935	$5,226
Field Overhead		15%	$20,804	$15,679
Subtotal			$180,297	$135,883
Profit		6%	$10,818	$8,153
Contingency		15%	$27,045	$20,382
Total			$218,159	$164,419

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost)	$237,686

Ramsdell Quarry Landfill Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Additional Site Characterization			
Delineation Sampling	ea	10	Assume 10 additional soil/sediment samples will be required to further define the limits of contamination. Assume hand sampling.
Sampling Labor	hrs	40	Assumes 2 sampling technicians at 10 hours/day for 2 days. Includes sampling, documentation, and travel.
Sampling Labor	$/hr	60	
Per Diem	$/event	460	2 people x $115/day
Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	36	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	9,840	Analyze samples for metals (12 @ $100), SVOC (12 @ 220), and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	18	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	7,621	
Civil Survey	day	2.0	Survey AOC for additional characterization samples, limits of excavation, and as-builts. RSMeans 01107 700 1200.
Civil Survey	$/day	885	
As Built Drawings	hours	16	Develop as-built drawings.
As Built Drawings	$/hr	60	
Clearing	acre	0.10	Assume trees/brush cleared, chipped, and left onsite.
Clearing	$/acre	4,025	RSMeans 022302000200. Clear and chip medium trees to 12" dia.
Install Signs on Posts	ea	4	Assume warning signs located around AOC perimeter at 100 ft centers. RSMeans 028907000100 & 1500. Add 50% for custom letters. Furnish, place, and install.
Install Signs on Posts	$/ea	185.25	
Soil Excavation			Includes excavation of the AOC areas based on the areas and depths presented in the summary table. In situ volumes include a 25% constructability factor.
Soil Excavation Volume (In situ)	cy	353	
Soil Excavation Volume (Ex situ)	cy	423	Includes soil volume to be transported and disposed. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Mass	tons	465	Includes soil mass to be transported and disposed.
Soil Excavation Surface Area	sf	7,621	
Volume to Weight Conversion	tons/cy	1.10	Ex situ or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	32.00	Includes 3/4 cy excavator, 2-22 cy off highway trucks,1 O.E., 1 T.D., 1 L.S. spotter, 2 L.S. to prep trucks/and misc. Reduced productivity by 40% for loading trucks, small precise excavations, and security/S&H requirements. Average 160 cy/day. RSMeans Crew B12-F.
Loading Soils	cy	423	2.5 cy FE Loader, 1 O.E., 2 L.S. Avg. 400 cy/day. RSMeans.
	$/cy	4.84	
Transport and Offsite Disposal	tons	465	Based on escalated 2004 vendor pricing.
	$/ton	34.80	

Ramsdell Quarry Landfill Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Dewatering Pad			
Dewatering Pad Area	sf	2,500	50 ft x 50 ft
Poly Liner	$/sf	0.75	
Drain/Sump/Pump/Berm	$/lot	1,500	Engineering estimate
Gravel Backfill	$/sf	0.57	Assume 6-in gravel layer. ECHOS 17030513.
Tarp and Ballast	$/sf	0.50	Engineering estimate
Dump Ramp	$/ea	3,000	Engineering estimate
Confirmational Sampling & Analysis			
Confirmation Samples	ea	9	Includes 7 multi increment (MI) samples. Also includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	24	Includes confirmation sampling labor. Assumes 1 sampling technician at 8 hours/day for 3 days.
Sampling Labor	$/hr	60	
Per Diem	$/event	345	1 person x $115/day
Truck Rental / Gas	$/event	370	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	18	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	2,880	Analyze samples for metals (9 @ $100) and SVOCs (9 @ 220) Includes 10% duplicate and 5% rinsate.
Data Management	hrs	9	Data validation
Data Management	$/hr	60	
Restoration			Includes native soil backfill. Assume productivity has been reduced by 25% to account for security and safety requirements. Add 20% premium for small job.
Native Soil Backfill	cy	423	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	22	
Seeding, Vegetative Cover	$/MSF	69.75	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 0.5 acres is revegetated for excavation areas and equipment damage.
Plans and Reports			
Corrective Action Completion Report	hrs	120	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	

Ramsdell Quarry Landfill Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
O&M Cost (Years 0 to 30)			
Sampling & Analysis	events	5	
Sampling & Analysis	years	5	Includes annual sampling for first 5 years. There are 5 total events. Assume 4 existing wells will be sampled and 3 soil/sediment samples collected in 1 day plus 1 day travel. Assumes 2 sampling technicians at 10 hours/day. Samples will be collected and analyzed for metals.
Annual Sampling Labor	days/event	2	
Annual Sampling Labor	hrs/event	40	
Annual Sampling Labor	$/hr	55	
Annual Per Diem	$/event	460	2 people x $115/day
Annual Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Sample materials	ea/event	18	Reference ECHOS 33 02 0401/0402 for disposable sampling and decon materials.
Sample materials	$/ea	21	
Annual Sample equipment	$/event	1,500	Water quality parameter equipment, pumps, misc tools, drums, and sampling equipment rental. Based on RACER model.
Analytical Cost	$/event	2,880	Analyze samples from 4 wells for metals (6 @ 100) and SVOCs (6 @ 220). Analyze 3 soil samples for metals (3 @ 100) and SVOCs (3 @ 220). Includes 10% duplicate and 5% rinsate.
Sample Shipment	$/event	100	2 coolers @ $50 ea.
Data Management	hrs	18	Data validation
Data Management	$/hr	60	
IDW Water Disposal	$/lot	700	Includes labor and travel to return IDW water to site after analysis.
Site Inspection and Maintenance	years	30	
Site Inspection	events	60	
Site Inspections	hrs	4	Inspect site semi-annually for disturbance/erosion, warning signs, and complete checklist for annual report.
Field Labor	$/hr	60	
Site Maintenance	events	30	
Site Maintenance	$/yr	200	Assume signs are replaced every 10 years. Assume AOC area is overseeded and fertilized every 5 years. Costs have been annualized.
Annual Report			
Sampling and Analysis Reports	event	5	
Sampling and Analysis Reports	$/event	2,800	Assume 40 hours @ $70/hr for report.
Annual O&M Report	event	30	
Annual O&M Report	$/year	560	Assume 8 hours @ $70/hr for letter report.
CERCLA Reviews			
CERCLA 5-Year Reviews	events	6	Assume 5 year reviews for 30 years.
CERCLA 5-Year Reviews	$/event	6,600	Assume 80 hours/review @ $70/hr. Add $1,000 misc expenses.

Ramsdell Quarry Landfill Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker
Cost Estimate

CAPITAL COST	$137,559

Activity (unit)	Quantity	Unit Cost	Total
Additional Site Characterization			
Sampling Labor (hrs)	40	$60.00	$2,400
Per Diem (event)	1	$460.00	$460
Truck Rental / Gas (event)	1	$280.00	$280
Confirmation Sample Materials (ea)	36	$21.00	$756
Sample Analysis (event)	1	$9,840.00	$9,840
Data Management (hrs)	18	$60.00	$1,080
Site Work			
Civil Survey (day)	2.0	$885.00	$1,770
As Built Drawings (hrs)	16	$60.00	$960
Clearing (acre)	0.1	$4,025.00	$403
Install Signs on Posts (ea)	4	$185.25	$741
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	353	$32.00	$11,280
Loading Soils (cy)	423	$4.84	$2,048
Transport and Offsite Disposal (ton)	465	$34.80	$16,192
Dewatering Pad			
Poly Liner (sf)	2,500	$0.75	$1,875
Drain/Sump/Pump/Berm (lot)	1	$1,500.00	$1,500
Gravel Backfill (sf)	2,500	$0.57	$1,435
Tarp and Ballast (sf)	2,500	$0.50	$1,250
Dump Ramp (ea)	1	$3,000.00	$3,000
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	24	$60.00	$1,440
Per Diem (event)	1	$345.00	$345
Truck Rental / Gas (event)	1	$370.00	$370
Confirmation Sample Materials (ea)	18	$21.00	$378
Sample Analysis (lot)	1	$2,880.00	$2,880
Data Management (hrs)	9	$60.00	$540
Restoration			
Native Soil Backfill (cy)	423	$10.76	$4,549
Seeding, Vegetative Cover (MSF)	22	$69.75	$1,535
Plans and Reports			
Corrective Action Completion Report (ea)	120	$70.00	$8,400
Subtotal			$82,707
Design		12%	$9,925
Office Overhead		5%	$4,135
Field Overhead		15%	$12,406
Subtotal			$109,174
Profit		6%	$6,550
Contingency		20%	$21,835
Total			$137,559

Ramsdell Quarry Landfill Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Security Guard/Maintenance Worker
Cost Estimate

OPERATION AND MAINTENANCE **$218,159**

Activity (unit)	Quantity	Unit Cost	Total Cost	Present Value (3.1%)
O&M Sampling & Analysis				
Sampling Labor (events)	5	$2,200	$11,000	$10,047
Per Diem (events)	5	$460	$2,300	$2,101
Cargo Van Rental / Gas (events)	5	$280	$1,400	$1,279
Sample materials (events)	5	$378	$1,890	$1,726
Sample equipment (events)	5	$1,500	$7,500	$6,850
Analytical Cost (events)	5	$2,880	$14,400	$13,152
Sample Shipment (events)	5	$100	$500	$457
Data Management (events)	5	$1,080	$5,400	$4,932
IDW Water Disposal (events)	5	$700	$3,500	$3,197
Site Inspection and Maintenance				
Site Inspection (ea)	60	$240	$14,400	$9,288
Site Maintenance (ea)	30	$200	$6,000	$3,870
Annual Report				
Sampling and Analysis Reports (ea)	5	$2,800	$14,000	$12,787
Annual O&M Report (ea)	30	$560	$16,800	$10,836
CERCLA Reviews				
CERCLA 5-Year Reviews (ea)	6	$6,600	$39,600	$24,006
Subtotal O&M			$138,690	$104,526
Design		10%	$13,869	$10,453
Office Overhead		5%	$6,935	$5,226
Field Overhead		15%	$20,804	$15,679
Subtotal			$180,297	$135,883
Profit		6%	$10,818	$8,153
Contingency		15%	$27,045	$20,382
Total			$218,159	$164,419

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost) **$355,718**

Ramsdell Quarry Landfill Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Capital Cost			
Land Use Controls			
Base Master Planning Documents	hrs	80	Assume 80 hrs to review and revise BMP documents.
Legal/Technical Labor	$/hr	80	
Additional Site Characterization			Assume 10 additional soil/sediment samples will be required to further define the limits of contamination. Assume hand sampling.
Delineation Sampling	ea	10	
Sampling Labor	hrs	40	Assumes 2 sampling technicians at 10 hours/day for 2 days. Includes sampling, documentation, and travel.
Sampling Labor	$/hr	60	
Per Diem	$/event	460	2 people x $115/day
Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	36	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	9,840	Analyze samples for metals (12 @ $100), SVOC (12 @ 220), and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	18	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	14,700	
Civil Survey	day	3.0	Survey AOC for additional characterization samples, limits of excavation, and as-builts. RSMeans 01107 700 1200.
Civil Survey	$/day	885	
As Built Drawings	hours	16	Develop as-built drawings.
As Built Drawings	$/hr	60	
Clearing	acre	0.10	Assume trees/brush cleared, chipped, and left onsite.
Clearing	$/acre	4,025	RSMeans 022302000200. Clear and chip medium trees to 12" dia.
Soil Excavation			Includes excavation of the AOC areas based on the areas and depths presented in the summary table. In situ volumes include a 25% constructability factor.
Soil Excavation Volume (In situ)	cy	679	
Soil Excavation Volume (Ex situ)	cy	815	Includes soil volume to be transported and disposed. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Mass	tons	896	Includes soil mass to be transported and disposed.
Soil Excavation Surface Area	sf	14,700	
Volume to Weight Conversion	tons/cy	1.10	Ex situ or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	32.00	Includes 3/4 cy excavator, 2-22 cy off highway trucks,1 O.E., 1 T.D., 1 L.S. spotter, 2 L.S. to prep trucks/and misc. Reduced productivity by 40% for loading trucks, small precise excavations, and security/S&H requirements. Average 160 cy/day. RSMeans Crew B12-F.
Loading Soils	cy	815	2.5 cy FE Loader, 1 O.E., 2 L.S. Avg. 400 cy/day. RSMeans.
	$/cy	4.84	
Transport and Offsite Disposal	tons	896	Based on escalated 2004 vendor pricing.
	$/ton	34.80	

Ramsdell Quarry Landfill Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Dewatering Pad			
Dewatering Pad Area	sf	2,500	50 ft x 50 ft
Poly Liner	$/sf	0.75	
Drain/Sump/Pump/Berm	$/lot	1,500	Engineering estimate
Gravel Backfill	$/sf	0.57	Assume 6-in gravel layer. ECHOS 17030513.
Tarp and Ballast	$/sf	0.50	Engineering estimate
Dump Ramp	$/ea	3,000	Engineering estimate
Confirmational Sampling & Analysis			
Confirmation Samples	ea	11	Includes 9 multi increment (MI) samples. Also includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	32	Includes confirmation sampling. Assumes 1 sampling technician at 8 hours/day for 4 days.
Sampling Labor	$/hr	60	
Per Diem	$/event	460	1 person x $115/day
Truck Rental / Gas	$/event	460	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	22	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	3,520	Analyze samples for metals (11 @ $100) and SVOCs (11 @ 220) Includes 10% duplicate and 5% rinsate.
Data Management	hrs	11	Data validation
Data Management	$/hr	60	
Restoration			Includes native soil backfill. Assume productivity has been reduced by 25% to account for security and safety requirements. Add 20% premium for small job.
Native Soil Backfill	cy	815	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	22	
Seeding, Vegetative Cover	$/MSF	46.50	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 0.5 acres are revegetated for excavation areas and equipment damage.
Plans and Reports			
Corrective Action Completion Report	hrs	160	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	

Ramsdell Quarry Landfill Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Cost Estimate

CAPITAL COST **$215,465**

Activity (unit)	Quantity	Unit Cost	Total
Land Use Controls			
Base Master Planning Documents (hr)	80	$80.00	$6,400
Additional Site Characterization			
Sampling Labor (hrs)	40	$60.00	$2,400
Per Diem (event)	1	$460.00	$460
Truck Rental / Gas (event)	1	$280.00	$280
Confirmation Sample Materials (ea)	36	$21.00	$756
Sample Analysis (event)	1	$9,840.00	$9,840
Data Management (hrs)	18	$60.00	$1,080
Site Work			
Civil Survey (day)	3	$885.00	$2,655
As Built Drawings (hrs)	16	$60.00	$960
Clearing (acre)	0.10	$4,025.00	$403
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	679	$32.00	$21,720
Loading Soils (cy)	815	$4.84	$3,944
Transport and Offsite Disposal (ton)	896	$34.80	$31,181
Dewatering Pad			
Poly Liner (sf)	2,500	$0.75	$1,875
Drain/Sump/Pump/Berm (lot)	1	$1,500.00	$1,500
Gravel Backfill (sf)	2,500	$0.57	$1,435
Tarp and Ballast (sf)	2,500	$0.50	$1,250
Dump Ramp (ea)	1	$3,000.00	$3,000
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	32	$60.00	$1,920
Per Diem (event)	1	$460.00	$460
Truck Rental / Gas (event)	1	$460.00	$460
Confirmation Sample Materials (ea)	22	$21.00	$462
Sample Analysis (lot)	1	$3,520.00	$3,520
Data Management (hrs)	11	$60.00	$660
Restoration			
Native Soil Backfill (cy)	815	$10.76	$8,760
Seeding, Vegetative Cover (MSF)	22	$46.50	$1,023

Ramsdell Quarry Landfill Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Cost Estimate

Activity (unit)	Quantity	Unit Cost	Total
Plans and Reports			
Corrective Action Completion Report (ea)	160	$70.00	$11,200
Subtotal			$124,604
Design		12%	$14,952
Office Overhead		5%	$6,230
Field Overhead		15%	$18,691
Subtotal			$164,477
Profit		6%	$9,869
Contingency		25%	$41,119
Total			$215,465