FINAL

FEASIBILITY STUDY

for Load Line 12

(RVAAP-12)

Ravenna Army Ammunition Plant
Ravenna, Ohio

July 2006

US Army Corps of Engineers®
Louisville District

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

SAIC®
From Science to Solutions™

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

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

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LIST OF ACRONYMS

3D	three-dimensional
AOC	area of concern
ARAR	applicable and relevant or appropriate requirement
AT123D	Analytical Transient 1-, 2-, 3-Dimensional
BERA	baseline ecological risk assessment
BGS	below ground surface
BHC	benzene hexachloride
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 constituent of concern
CMCOPC	contaminant migration constituent of potential concern
COC	constituent of concern
COEC	constituent of ecological concern
COPC	constituent of potential concern
COPEC	constituent of potential ecological concern
CSM	conceptual site model
CTT	closed, transferring, and transferred
DCE	dichloroethylene
DERR	Department 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
EPA	U. S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ESA	Endangered Species Act
ESV	ecological screening value
EU	exposure unit
F&T	fate and transport
FRTR	Federal Remediation Technologies Roundtable
FS	feasibility study
FWGWMP	Facility-wide Groundwater Management Plan

LIST OF ACRONYMS (CONTINUED)

FWHHRAM	Facility-Wide Human Health Risk Assessor Manual
GRA	general response action
GSA	U. S. General Services Administration
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
ILCR	incremental lifetime cancer risk
IRP	Installation Restoration Program
LDR	land disposal requirement
MCL	maximum contaminant level
MDC	maximum detected concentration
MEC	munitions and explosives of concern
ML	large mark
MMRP	Military Munitions Response Program
MNA	monitored natural attenuation
MTR	minimum technical requirement
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NGB	National Guard Bureau
NPDES	National Pollutant Discharge Elimination System
O&M	operation and maintenance
OAC	Ohio Administrative Code
ODNR	Ohio Department of Natural Resources
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
POTW	publicly owned treatment works
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

LIST OF ACRONYMS (CONTINUED)

RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RGO	remedial goal option
RI	remedial investigation
ROD	record of decision
RQL	Ramsdell Quarry Landfill
RRSE	Relative Risk Site Evaluation
RTLS	Ravenna Training and Logistics Site
RVAAP	Ravenna Army Ammunition Plant
S/S	stabilization/solidification
SAIC	Science Applications International Corporation
SDMP	scientific decision management point
SERA	screening ecological risk assessment
SESOIL	Seasonal Soil Compartment Model
SRC	site-related contaminant
SVE	soil vapor extraction
SVOC	semivolatile organic compound
TAL	target analyte list
TBC	to be considered
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TERP	Transportation and Emergency Response Plan
THI	target hazard index
TNT	trinitrotoluene
TR	target risk
TRV	toxicity reference value
TSCA	Toxic Substances Control Act
TU	temporary unit
UCL_{95}	95% upper confidence limit
UHC	underlying hazardous constituent
USACE	U. S. Army Corps of Engineers
USACHPPM	U. S. Army Center for Health Promotion and Preventive Medicine
USEPA	U. S. Environmental Protection Agency
USGS	U. S. Geologic Survey
UTS	universal treatment standards
VOC	volatile organic compound

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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 Load Line 12 (RVAAP-12). Load Line 12 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 Load Line 12 Remedial Investigation (RI) phase is complete. The RI phase of work indicates evidence of impacts that requires further evaluation in a Feasibility Study (FS). This report documents the FS for soil and dry sediment media at Load Line 12 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 Load Line 12. 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 sediments are evaluated to ensure that 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 during implementation to ensure protectiveness of surface water during implementation.

Although remediation of impacts to groundwater, surface water, and wet sediments are not addressed in this FS, a preliminary evaluation of options to address impacts to groundwater, surface water, and wet sediments is included in the appendices of this FS.

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 Load Line 12. To provide this protection, media-specific objectives that identify major contaminants and associated media-specific cleanup goals are developed. The RAOs specify contaminants of concern (COCs), exposure routes and receptors, and acceptable constituent concentrations for long-term protection of receptors. Operational history of the AOC indicates the potential for munitions and explosives of concern at the AOC, which will be addressed under the Military Munitions Response Program.

Based on these considerations, land use for Load Line 12 under a restricted (military mission) use will be controlled and a National Guard Trainee 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 foreseeable land use at the current time. Table ES-1 lists the receptor for each land use scenario at Load Line 12.

Table ES-1. Land Use Scenarios Assessed in the Load Line 12 FS

AOC	Land Use Scenario	Receptor
Load Line 12	Restricted	National Guard Trainee
	Residential	Resident Subsistence Farmer

The following RAO is developed accordingly for impacted soils and dry sediments at Load Line 12:

- Prevent National Guard Trainee exposure to contaminants in soils and dry sediments that exceed risk-based cleanup goals to a depth of 4ft below ground surface.

ES.2.1 Identification of Human Health Preliminary Cleanup Goals for Load Line 12

Preliminary cleanup goals were developed to support the remedial alternative selection process for soil remediation at Load Line 12. Preliminary cleanup goals are the chemical-specific, risk-based values used to meet the RAO for protection of human health. A summary of the preliminary cleanup goals for the COCs identified for evaluation of remedial alternatives in this FS is provided in Table ES-2 for the National Guard Trainee and Resident Subsistence Farmer land use.

Table ES-2. Summary of COCs and Preliminary Cleanup Goals for Evaluation of Remedial Alternatives for Load Line 12

COC	Soil Preliminary Cleanup Goal (mg/kg)	Sediment Preliminary Cleanup Goal[a] (mg/kg)	Surface Water Preliminary Cleanup Goal (mg/L)	Groundwater Preliminary Cleanup Goal (mg/L)
Representative Land Use (Mounted Training, no digging – National Guard Trainee)				
Arsenic	--	31[f]	--	--
Residential Land Use (Resident Subsistence Farmer)				
Arsenic	--	20[f]	--	--
Nitrate	--	--	1.7[d]	17
Silver	--	370[d]	0.051[d]	--
2,4,6-Trinitrotoluene	32[b]	--	--	--
Benzo(*a*)pyrene	0.59[b,c]	0.59[e]	--	--
Benzo(*b*)fluoranthene	--	5.9[e]	--	--
Dibenz(*a*,*h*)anthracene	0.59[b]	0.59[e]	--	--
Aroclor-1016	--	1.2[f]	--	--
Aroclor-1254	--	1.2[f]	--	--

[a]Preliminary cleanup goals are the same for wet and dry sediments.
[b]COC for shallow surface soil [0 to1 ft below ground surface (BGS)] at the Western Soil Aggregate.
[c]COC for shallow surface soil (0 to 1 ft BGS) and subsurface soil (1 to 3 ft BGS) at the Western Soil Aggregate.
[d]COC at the Active Area Channel.
[e]COC at the Upgradient Location.
[f]COC at the Main Ditch.
COC = Chemical of concern.
-- = Chemical is not a COC for evaluation of remedial alternatives in this feasibility study for this medium.

ES.2.2 Ecological Preliminary Cleanup Goals for Load Line 12

The ecological risk assessment performed for Load Line 12 is available in the RI Report and summarized in Chapter 2 of this FS. The Ohio Environmental Protection Agency (Ohio EPA) Levels I, II, and III were performed for Load Line 12 and show observed concentrations and toxicity reference values where hazard quotients (HQs) exceed 1. The risk assessment in the RI Report identifies a variety of ecological receptor populations that could be at risk and identify the chemicals of potential ecological concern and chemicals 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 Load Line 12. This recommendation comes from applying steps in the Facility-wide Ecological Risk Work Plan and specifically steps in Figure III to reach a scientific decision management point (SDMP) that few ecological resources are at risk. This recommendation is based principally on the following weight-of-evidence conclusions:

- Field observations (Level I of the Ohio EPA Protocol) indicate that there were few adverse ecological effects before the land was cleared (USACE 2004a), and there is ample nearby habitat to restore ecological communities at Load Line 12 and maintain them elsewhere on the RVAAP/Ravenna Training and Logistics Site. These observations imply that remediation to protect ecological resources is not necessary.

- A few adverse ecological effects from military training activities (e.g., mounted training and no digging) may occur, including, tank trails and brush hogging in an already heavily altered and disturbed habitat. Any remediation of habitat would tend to be re-disturbed by repeated military training activities and, thus, reduce the benefits of any remediation.

- Soil HQs are generally not highly elevated and metal concentrations are similar to background for many COECs.

- Potential remediation to meet human health preliminary cleanup goals would reduce overall contaminant concentrations.

- Additional remediation of soils and dry sediments to meet human health requirements would further reduce any adverse ecological effects, but would destroy habitat without substantial benefits to the ecological resources at Load Line 12.

More information about the dual protectiveness of human health and ecological resources is found in Table 7-3.

ES.2.3 Extent and Volume Calculations

Estimated volumes are generated of impacted soils and/or dry sediments at Load Line 12 where COCs in these media were identified 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 estimated volumes of impacted soil and dry sediment for residential land use and the estimated volume of impacted sediment for National Guard Trainee land use are summarized in Table ES-3.

Table ES-3. Estimated Volumes of Impacted Soils/Dry 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)
Load Line 12 National Guard Trainee Land Use – Dry Sediment*	10,600	20,900	774	26,125	968	31,350	1,161
Load Line 12 Resident Subsistence Farmer Land Use – Dry Sediment*	11,706	21,453	794	26,816	993	32,180	1,191
Load Line 12 Resident Subsistence Farmer Land Use – Soil	103,372	198,168	11,337	247,710	14,171	297,252	17,006

[a] Includes 25% constructability factor.
[b] Includes 20% swell factor.
*Volumes are calculated based on sediment removal varying from 0.5 to 2.0 ft in depth.

ES.3 DEVELOPMENT OF REMEDIAL ALTERNATIVES

Remedial alternatives assembled for impacted soils at Load Line 12 are presented in Table ES-4. The remedial alternatives were constructed by combining general response actions, technology types, and process options retained from the screening processes described in the previous section. Remedial alternatives should assure adequate protection of human health and the environment, achieve RAOs, meet applicable and relevant or appropriate requirements, and permanently and significantly reduce the volume, toxicity, and/or mobility of COCs.

ES.4 RECOMMENDED ALTERNATIVE

The recommended alternative for Load Line 12 is Alternative 3 (Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use). This alternative involves the removal of dry sediment in the Main Ditch at Load Line 12 that exceeds preliminary cleanup goals for the National Guard Trainee. This alternative is protective until arsenic concentrations are at or below the preliminary cleanup goal. This alternative is protective for the anticipated future land use (National Guard Trainee), is cost effective (estimated $364,789 for removal), and can be performed in a timely manner. Following the removal, land use controls and 5-year reviews will be necessary to restrict access to Load Line 12. Access restrictions are already being implemented at Load Line 12 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. Five-year reviews would not be conducted in accordance with CERCLA 121(c)
Alternative 2 – Limited Action This remedial alternative involves 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 digging, no use of groundwater) would be developed and implemented by the U.S. Army and OHARNG. Five-year reviews would be conducted in accordance with CERCLA 121(c)
Alternative 3 – Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use This remedial alternative involves the removal and transportation of impacted soils/dry sediments above National Guard Trainee 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 ensure land use preliminary cleanup goals have been achieved. Areas successfully remediated would be backfilled with clean soils, if appropriate. 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., soils, groundwater, and sediment) would be conducted to assess potential for offsite contaminant migration. The remedial action includes an O&M period. Five-year reviews would be conducted in accordance with CERCLA 121(c)
Alternative 4 – Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soils/dry sediments 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 ensure Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Areas successfully remediated would be backfilled with clean soils. Environmental monitoring (i.e., groundwater) would be conducted under the auspices of the Ohio EPA Director's Findings and Orders. Alternative 4 does not include O&M as residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative

Table ES-4. Summary of Remedial Alternatives (continued)

Alternative 5 – Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use This remedial alternative involves the removal and transportation of impacted media above National Guard Trainee land use preliminary cleanup goals for treatment and offsite disposal. Impacted soils/dry sediments would be excavated and transported to a central treatment area. Treatment would consist of mixing stabilization/solidification admixtures with excavated soils/dry sediments per the performance parameters established through a treatability study. Sampling will be conducted to ensure successful treatment. Treated soils/dry sediments would then be transported to an offsite disposal facility licensed and permitted to accept the wastes. Confirmation sampling would be conducted to ensure land use preliminary cleanup goals have been achieved. Land use controls would be instituted/maintained including existing access restrictions, restrictions to prohibit changes in land uses, and periodic inspection of the AOC to determine any changes in land use. Periodic environmental monitoring (i.e., groundwater and surface water) would be conducted to assess the potential for offsite contaminant migration. The remedial action includes an O&M period. Five-year reviews would be conducted in accordance with CERCLA 121(c)
Alternative 6 – Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use This remedial alternative involves the removal and transportation of chemical contamination in soils/dry sediments above Resident Subsistence Farmer land use preliminary cleanup goals for treatment and offsite disposal. Impacted soils/dry sediments would be excavated and transported to a staging area for treatment. Impacted soils/dry sediments would be excavated and transported to a central treatment area. Treatment would consist of mixing stabilization/solidification admixtures with excavated soils/dry sediments per the performance parameters established through a treatability study. Sampling will be conducted to ensure successful treatment. Treated soils/dry sediments would then be transported to an offsite disposal facility licensed and permitted to accept the wastes. Confirmation sampling would be conducted to ensure Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Environmental monitoring (i.e., groundwater) would be conducted under the auspices of the Ohio EPA Director's Findings and Orders. Alternative 6 does not include O&M because residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative

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

1.0 INTRODUCTION

Science Applications International Corporation (SAIC) has been contracted by the US 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 2005h). In addition, planning and performance of 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 EPA 2004).

1.1 PURPOSE

This Feasibility Study (FS) evaluates remediation alternatives to achieve remedy for soils and dry sediments at Load Line 12. Remediation of impacts to aqueous media (groundwater and surface water) and underwater (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 FS 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 Load Line 12 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 Load Line 12 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 Load Line 12 in accordance with remedial action objectives (RAOs) and to obtain remedy for (or cleanup of) soils and dry sediments. The remedial activities include no further action, limited action, and removal/treatment of soils/dry sediments. RAOs are developed in the FS to protect receptors from impacted environmental media and constituents of concern (COCs) identified in the Load Line 12 RI Report (USACE 2004a). 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 evaluations 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 of Load Line 12. In addition, residual soils are evaluated to demonstrate that the evaluated remedy is protective of groundwater at Load Line 12 with respect to the anticipated future land uses. Remediation of aqueous media (i.e., groundwater and surface water), and wet sediments is not included in this FS. However, a preliminary evaluation of options to address impacts to aqueous media and wet sediments is included in this FS. Remedies for soils and dry sediments also incorporate the necessary engineering controls during implementation to ensure protectiveness of surface water during implementation.

In addition, removal actions specifically addressing munitions and explosives of concern (MEC) issues or the potential environmental impact from MEC removal are not included in the scope of this FS. 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/Ravenna Training and Logistics Site (RTLS) that are known or suspected to contain MEC, including Load Line 12.

Ohio Army National Guard (OHARNG) has established future land uses for Load Line 12 based on anticipated training, mission, and utilization of the RTLS (USACE 2004c). 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.

1.3 REPORT ORGANIZATION

The organization of this report is based on the U. S. Environmental Protection Agency (USEPA) guidance and includes ten major chapters. This report presents the findings of the FS conducted for Load Line 12 and is organized as follows:

- Chapter 2: Background Information,
- Chapter 3: RAOs,
- Chapter 4: ARARs,
- 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 AOC 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 AOC 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 3A: contaminant fate and transport assessment,
- Appendix 3B: volume estimates of impacted soils,
- Appendix 5: initial screening of technologies for aqueous media, and
- Appendix 7: detailed cost estimates.

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2.0 BACKGROUND INFORMATION

2.1 FACILITY-WIDE BACKGROUND INFORMATION

2.1.1 General Site 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 1-1 and 1-2). The RTLS is surrounded by several communities: Windham on the north; Garrettsville 9.6 km (6 miles) to the northwest; Newton Falls 1.6 km (1 mile) to the southeast; Charlestown to the southwest; and Wayland 4.8 km (3 miles) to the south.

When the RVAAP was operational, the RTLS did not exist and the entire 21,683-acre parcel was a government-owned, contractor-operated industrial facility. The RVAAP IRP encompasses investigation and cleanup of past activities over the entire 21,683 acres of the former RVAAP and, therefore, references to 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 8,668.3 ha (21,419 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. 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, 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. Geologic Survey (USGS) 1968]. This province is characterized by elevated uplands underlain primarily by Mississippian- and Pennsylvanian-age bedrock units that are horizontal or gently dipping. The province is characterized by its rolling topography with incised streams having dendritic drainage patterns. The Southern New York Section has been modified by glaciation, which rounded ridges, filled major valleys and blanketed many areas with glacially derived unconsolidated deposits (i.e., sand, gravel, and finer-grained outwash deposits). As a result of glacial activity in this section, old stream drainage patterns were disrupted in many locales, and extensive wetland areas developed.

2.2 LOAD LINE 12

2.2.1 Load Line 12 History

Load Line 12 is located in the southeastern portion of the facility and is approximately 80 acres in size (Figure 2-2). Load Line 12 was originally known as the Ammonium Nitrate Plant, and started operations on November 25, 1941. Structures related to the production of the ammonium nitrate were the Neutral Liquor Building (FE-19), seven evaporation/crystallization units (Buildings 900, 901, 902, 903, 904, 905, and 906), and an above-ground 15-cm (6-in.)-diameter pipeline. Other structures include Water Works No. 2, Power House No. 3 (FE-17), the bagging and shipping building (FN-54), a compressor building (FA-20), an administration building (FE-53), a change house (FEWP-22), a laboratory (FE-52), a clock house (4-51), and a sanitary sewer lift station situated near the northeast corner of the load line. The southern part of the AOC held a steam plant that used fuel oil and coal as fuel during its operation. In May 1943, production of ammonium nitrate was terminated. From 1946 to 1950, a private contractor leased Load Line 12 to produce fertilizer-grade ammonium nitrate. From 1965 to 1967, another private contractor leased Building FF19 for the production of aluminum chloride. The US Army terminated the lease early due to environmental concerns related to air emissions and wastewater discharges to Cobb's Pond. An aluminum chloride release was responsible for a November 15, 1966, fish kill in Cobb's Pond. The pond was drained and dredged with the sludge going to RQL.

In June 1944, Buildings 900, 904, and 905 were converted for demilitarization of munitions using a hot-water washout process. Washout operations were converted to a steam melt-out process in the late 1950s. Reportedly, spillage from this operation was usually cleaned from floors and equipment with hot water/steam. Initially the rinsate was allowed to flow out of the buildings and directly onto the ground. Later a system of scuppers/gutters was installed along the perimeter of the building floor to channel the washdown effluent through a series of stainless steel tanks. Until 1981, the tank effluent flowed through a ditch to a holding pond, which drained into Upper Cobb's Pond and then to Lower Cobb's Pond. In 1981, the Load Line 12 Pink Water Treatment Plant was built within the confines of Load Line 12 to treat the demilitarization effluent. After the termination of demilitarization operations, the plant was used under a National Pollutant Discharge Elimination System (NPDES) permit to treat explosives-tainted stormwater from Load Line 12 and other RVAAP locations.

Currently there are no above-grade structures remaining at the AOC except for a small portion of the floor slab of Building FF19. Demolition of Buildings 901, 902, 906, and FF19 took place between 1973 and 1975, and included open burning of wooden debris. Building 54 was demolished in the 1980s. In 1999, approximately 1,500 ft^3 of soil was removed from four pits near Building 904 and taken to a Load Line 4 warehouse as part of an explosives composting pilot study. Demolition of remaining structures took place between 1998 and 2000. A former blast berm near Building 903 was removed and used as fill/groundcover for areas around Building 903 and FE-17. The general flat topography can be seen in Photograph 2-1.

Photograph 2-1. AOC Conditions at Load Line 12, April 2005

2.2.2 Load Line 12 Surface Features

Elevations across Load Line 12 range from approximately 296 to 301 m (970 to 987 ft) above mean sea level. AOC topography and other surface features can be seen in Figure 2-3. Adjacent to former Buildings 904, 905, and 906 in the western portion of the AOC is a low, marshy area. Structural features include gravel access roads, man-made ditches, sanitary sewer lines, manholes, the remnants of floor slabs, and the remains of three main rail tracks and several secondary tracks. The surface soil has been highly disturbed by demolition activities that occurred between the Phase I and Phase II RIs. Soils in areas that have undergone heavy construction and/or demolition include sandy fill, sand, ballast material, slag, and residual debris such as metal, brick, and concrete. Relatively undisturbed soils are silty clays, silty sands, and clayey silt.

2.2.3 Previous Investigations

The following assessments and/or investigations were conducted at Load Line 12:

- 1996 U. S. Army Center for Health Promotion and Preventive Medicine (USACHPPM) Relative Risk Site Evaluation (RRSE),
- Preliminary Assessment for the RVAAP (USACE 1996),
- Phase I RI for High-Priority AOCs at the RVAAP (USACE 1998a),
- August 2001 additional USACE sampling,
- Phase II Supplemental Remedial Investigation (USACE 2004a),
- Preliminary Draft Report for the Characterization of 14 RVAAP AOCs (MKM 2005), and
- RVAAP Load Line 12 Phase II RI Supplemental Report (USACE 2005g).

The Preliminary Assessment of Load Line 12 performed in 1996 included the AOC in the list of high priority sites based on a relative risk ranking methodology. Re-evaluation of the Load Line 12 risk ranking performed at the completion of the Phase I RI resulted in the AOC retaining its “High Risk” rating. The Phase I RI performed in 1996 included sampling and analysis of surface soil [0-1 ft below ground surface (BGS)], ditch sediment, and sediment from the Building 904 settling basin. The Phase I results indicated concentrations of explosives, inorganics, and organic compounds occurring in soil and sediment throughout the production area above risk-based screening values. The Phase II RI included investigation of the groundwater at Load Line 12. Additional groundwater characterization was conducted during the 14 AOCs RI and was summarized in the Phase II RI Supplemental Report.

2.2.4 Nature and Extent

Nature and extent of contamination at Load Line 12 was determined based on the evaluation of the Phase II RI data. Figure 2-4 shows the soil sample locations, Figure 2-5 shows sediment and surface water sample locations, and Figure 2-6 presents the location of groundwater monitoring wells at Load Line 12. The surface (0-1 ft BGS) and subsurface (1-7 ft BGS) soil, sediment, and surface water were divided into spatial aggregates based on former process operations and drainage areas. Surface soil (0-1 ft BGS) and subsurface soil (1-7 ft BGS) were divided into two aggregates: areas believed to be impacted by process-related activities (Western Soil Aggregate) and areas believed to be relatively non-contaminated (Eastern Soil Aggregate). Sediment and surface water were grouped by drainage areas into five aggregates to facilitate examination of contaminants spread by these media and to focus on the receptor exposure points for the baseline human health and screening ecological risk assessments. Groundwater was considered on an AOC-wide basis. The results of this evaluation are summarized by medium.

2.2.4.1 Surface Soils

The occurrence and distribution of contaminants in surface soil (0-1 ft BGS) differ between the Eastern and Western Soil Aggregates. Explosives were not detected in surface soil of the Eastern Aggregate but were somewhat widespread in the Western Aggregate. Although some inorganics and semivolatile organic compounds (SVOCs), in particular polycyclic aromatic hydrocarbons (PAHs), were detected across both soil aggregates, the concentrations are substantially different between aggregates. Of the inorganics determined to be site-related contaminants (SRCs) in the Eastern Aggregate, none exceeded 3 times their respective background levels.

In contrast, nine inorganic SRCs identified for surface soil (0-1 ft BGS) in the Western Aggregate exceeded their respective facility-wide background values by more than 10 times. The maximum concentrations of PAHs are generally 2 orders of magnitude higher in the Western Aggregate than PAH concentrations in the Eastern Aggregate. This pattern also holds true for pesticides and polychlorinated biphenyls (PCBs), which were not detected in Eastern Aggregate soils but occur in some areas within the Western Aggregate. Volatile organic compounds (VOCs) do not appear to be a significant contaminant in surface soil of either aggregate.

2.2.4.2 Subsurface Soil

Subsurface soil samples were collected from 1 to 7 ft BGS. Explosives are present in subsurface soil in the vicinity of Buildings FF19, 900, 904, and 905. The explosive 2,4,6-TNT is the most commonly occurring explosive, with the highest concentrations detected in the footprints of Buildings 904 and 905. Nitrocellulose was the only propellant detected in subsurface soil. This compound occurs in subsurface soil at Buildings FF19, 900, 904, and 905. The inorganics detected at concentrations exceeding their respective background most frequently include antimony, copper, lead, mercury, and zinc. As with surface soil, inorganics above background are most prevalent in subsurface soil in the vicinity of Building FF19. Additional occurrences of inorganics above background are also associated with Building 904 and the Team Track Area. PAHs occur in the Building FF19 and the FE-17 Power House building areas. Isolated occurrences of PAHs are also associated with Building 904 and the Team Track Area. Methylene chloride and toluene were detected in seven subsurface soil samples collected in the vicinity of Buildings FF19, FE-17, 52, and 904 and the Team Track Area. Pesticides are generally absent from subsurface soil at Load Line 12. Three pesticide compounds were detected at only two sampling stations at Load Line 12, one associated with Building FF19 and one at Building 905. As with surface soil, PCB-1260 is the most common PCB compound in subsurface soil, occurring primarily in soil to depths of 1.5 m (5 ft) in the vicinity of Building FF19.

2.2.4.3 Sediment

Sediment samples were divided into four aggregates based on drainage area: the Main Ditch, the Active Area Channel, the West Ditch, and the Channel North of the Active Area. The following SRCs occur in sediment across all aggregates: aluminum, antimony, beryllium, cadmium, chromium, cobalt, copper, mercury, nickel, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, fluoranthene, phenanthrene, and pyrene. Explosives concentrations in sediment were < 1 mg/kg and limited to the West Ditch at Building 905 and the station furthest downstream of the process area near Upper Cobb's Pond. In general, explosives in sediment were detected at much lower concentrations during the Phase II RI than during the Phase I RI. This may indicate that impacted sediment was buried or mixed with uncontaminated sediments over time, especially during building demolition and grading conducted in 2000.

Ditch sediment in the Main Ditch and West Ditch has been impacted by inorganics. Cadmium, copper, and mercury were detected at concentrations exceeding their respective background at every station near Buildings FF19, FN-54, 902, and 905. The upgradient sampling location L12-228 is a "hot spot" for SVOCs, particularly PAHs. Thus, the presence of SVOCs in the Active Area Channel and stream channel north of the Active Area may not be due to activities at Load Line 12 but rather to inputs from the Atlas Scrap Yard or the roadway at the western AOC boundary. PAHs were also detected frequently in the Main Ditch and West Ditch aggregates.

The VOCs detected in sediment included acetone, 2-butanone, trichloroethene (TCE), dichloroethylene (DCE), methylene chloride, and toluene. Methylene chloride and 2-butanone were the most frequently occurring VOCs, with the most detections occurring in the West Ditch aggregate near Buildings FN-54 and in the Channel North of the Active Area. PCB-1254 and PCB-1260 were the most frequently detected PCBs in sediment, occurring primarily in the West Ditch and Main Ditch. Pesticides and PCBs were absent from sediment in the Channel North of the Active Area. SRCs in sediment that have migrated to the downstream location (station L12-229) include 1,3-dinitrobenzene(DNB), antimony, cadmium, cobalt, mercury, nickel, silver, 2-butanone, acetone, benzo(b)fluoranthene, and fluoranthene.

2.2.4.4 Surface Water

Surface water samples were divided into the same aggregates as sediment samples: the Main Ditch, the Active Area Channel, the West Ditch, and the Channel North of the Active Area. The following SRCs occur in surface water across all aggregates: 2,4-dinitrotoluene (DNT), barium, cadmium, cobalt, copper, manganese, nickel, vanadium, and zinc. Explosives were detected in all surface water aggregates at low concentrations; surface water in the Active Area Channel contains the highest concentrations of explosives contamination. Explosives were not detected in surface water at the station furthest downstream (L12-229). Surface waters in the West Ditch aggregate have been impacted by inorganics. Barium, cadmium, chromium, cobalt, copper, nickel, and zinc were detected at concentrations exceeding their respective background at every station in ditches near Buildings 900, 905, and FN-54. Nitrate was detected at 2.1 times the maximum contaminant level (MCL) for drinking water in the West Ditch, near Building 900. SVOCs and VOCs are not widespread in surface water. Detections of bis(2-ethylhexyl)phthalate and methylene chloride were limited to the West Ditch near Building 900 and the northern AOC boundary. Pesticides and PCBs are absent from surface water at Load Line 12. SRCs in surface water that have migrated to the downstream location include cobalt, nickel, and vanadium. However, surface water has transported an additional nine SRCs in sediment from the process area to this station, which may reflect flux of additional contaminants in the past during load line operations.

2.2.4.5 <u>Groundwater</u>

Groundwater samples collected during the Phase II RI contained detectable quantities of explosives and target analyte list (TAL) metals in all wells. Wells in the northern half of the AOC, particularly near Building 900, the northern boundary, and the Team Track Area (triangular area of land between two spurs from Track FA and Ramsdell Road that lead into Load Line 12 from the north), are most contaminated. Arsenic and thallium were detected above MCLs. Nitrate was detected only in wells adjacent to primary ammonium nitrate production areas, suggesting that contaminants have not migrated far from source areas. SVOCs and PCBs/pesticides are minor contaminants in Load Line 12 groundwater. Occurrences of SVOCs in groundwater do not correspond to source areas for SVOCs in surface or subsurface soil.

Based on available groundwater to date, only trace concentrations of explosives have been observed along the downgradient boundaries of Load Line 12. The Phase II RI included installation of wells LL12mw-182 and LL12mw-183 along the southern boundary of the AOC (closest to the installation boundary). These wells were most recently sampled in 2004 and 2005. 1,3,5-Trinitrobenzene was detected in only the 2005 samples at estimated concentrations less than laboratory reporting limits [<0.1 part per billion (ppb)]. Well LL12mw-246, installed during the 14 AOC investigation along the southeastern downgradient boundary of the AOC, was sampled in 2004 and contained no detectable explosives. Well LL12mw-186, installed during the Phase II RI along the northern boundary of the AOC, was also most recently sampled in 2004 and 2005 and contained only 4-nitrotoluene at an estimated concentration of 0.057 ppb. Several of these wells will continue to be monitored under the RVAAP Facility-Wide Groundwater Management Plan (FWGWMP).

Results for the 2004/2005 monitoring events show a decrease in the total numbers of explosives and propellants detected in groundwater at Load Line 12 since the time of the 2000 RI with the exception of nitrocellulose. Nitrocellulose was the only constituent that exhibited a notable increase in concentration between sampling events. The wells showing nitrocellulose increases were all located adjacent to former production buildings.

Recent monitoring data did not show substantial changes in the numbers and concentrations of TAL metals identified as SRCs, with the exception of aluminum and zinc, which showed increases of average concentrations. Only one zinc result exceeded background. Filtered samples show that arsenic continued to exceed its primary drinking water MCL and background at several wells, although the background also exceeds the MCL. Elevated arsenic is indigenous to the glacial soils at RVAAP; maximum soil concentrations at Load Line 12 ranged only from 1.4 to 3.3 times background. Thallium was identified above its MCL in well LL12mw-185 during the Phase II RI, but was not detected during 2004 sampling.

Nitrate concentrations in one source area well near Building 901 increased over the time period between investigations. However, nitrate concentrations decreased in most other wells where it was previously detected.

Results of additional groundwater investigations conducted since 2000 do not substantially alter the results of the contaminant nature and extent evaluation presented in the Phase II RI. New wells installed in 2004 did not reveal previously unknown geologic conditions or features that would serve as preferential contaminant migration pathways. Potentiometric data collected in January 2005, including the five new wells, show a generally consistent water table configuration as that observed during previous investigations at the AOC.

With the exception of nitrocellulose, the number and concentrations of explosives and propellants in recent groundwater samples were generally lower than that observed in 2000. Results for inorganic analyses do not show substantial changes in the types and concentrations of metals in groundwater. Nitrate concentrations in one source area well (LL12mw-187) near former Building 901 increased over the intervening time period between investigations. However, nitrate concentrations decreased in most other wells where it was previously detected.

The more recent groundwater results continue to suggest that contaminant mobility is limited within the low permeability silt to silty clays comprising the unconsolidated zone. Wells along the southern boundary of the AOC (LL12mw-182 and -183) continue to show undetectable or extremely low trace levels of the principal contaminants observed within the AOC (e.g., explosives or nitrate), thus indicating that migration off of the AOC to the south has not occurred. Likewise, 2004/2005 monitoring data do not indicate preferential migration of contaminants to the north along the surface drainage route. The 2004/2005 monitoring results have not shown migration to the northwestern and southern AOC boundaries to date, as suggested by conservative numerical modeling predictions.

2.2.4.6 Sanitary Sewer Water and Sediment

Sewer water and sediment samples were collected from the sanitary sewer system during the Phase II RI to determine whether the system represents an accumulation point for contaminants introduced via building floor and sink drains during AOC operations.

Explosives were detected at low concentrations in sewer water at all locations sampled. The most frequently detected compounds were hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); 2,4-DNT; 2-amino-4,6-DNT; and 4-amino-2,6-DNT. Sediment and water at two stations, L12-218 and L12-219, are impacted by inorganics. Mercury was detected in sediment at L12-219 at a concentration 267 times greater than its respective background. The copper concentration in sediment at L12-218 was 31 times its background. Nitrate was detected in sewer water at every station sampled, with a maximum concentration of 10,600 μg/L. Cyanide was not detected in water or sediment at any station sampled. Three PAHs were detected in one sediment station but at much lower concentrations than at the upgradient stations. One VOC and several pesticides/PCBs were also detected in sediment. One pesticide, heptachlor epoxide, was detected in sewer water at three stations. No SVOCs or VOCs were detected in sewer water.

2.2.5 Fate and Transport Analysis

Contaminant fate and transport modeling performed as part of the Phase II RI included leachate modeling Seasonal Soil Compartment Model (SESOIL) at selected source areas in the Western Soil Aggregate (i.e., Buildings 904, 905, FF19, etc.) and Eastern Soil Aggregate, and groundwater modeling Analytical

Transient 1-, 2-, 3-Dimensional (AT123D) from the sources to selected receptors or exit points from the AOC. For the Eastern Soil Aggregate, source areas were defined by the maximum concentrations at individual sampling stations. Fate and transport modeling indicates that metals and explosives may leach from contaminated soils into the groundwater beneath the source areas. Migration of many of the constituents, however, has been attenuated because of moderate to high retardation factors.

2.2.5.1 SESOIL Modeling

In the Eastern Soil Aggregate, SESOIL modeling results indicate that chromium and nickel are predicted to leach to groundwater with concentrations exceeding groundwater risk-based concentrations or MCLs beneath sampling points. For the purpose of numerical modeling comparisons, the U.S. Environmental Protection Agency (EPA) Region 9 preliminary remediation goals (PRGs) are used for risk-based concentrations. In the Western Aggregate, groundwater concentrations from leachate loading predicted to exceed groundwater Region 9 Residential PRGs/MCLs include five metals, seven explosives, one pesticide, and one VOC identified as contaminant migration constituents of potential concern (CMCOPCs) based on source loading predicted by the leachability analysis or on measured groundwater concentrations downgradient of the sources listed below:

- Antimony; chromium; manganese; 1,3-DNB; 2,4-DNT; 2,6-DNT; 4-nitrotoluene; and RDX at Building 904. Measured groundwater concentrations exceeded Region 9 Residential PRGs/MCLs, and predicted concentrations for 2,4-DNT and the pesticide beta-benzene hexachloride (BHC), indicating that leaching processes have already occurred.

- Groundwater concentrations predicted by leachate modeling exceed Region 9 Residential PRGs/MCLs beneath Building 905 for barium; chromium; 1,3-DNB; 2,4-DNT; and RDX. Groundwater concentrations downgradient of Building 905 exceed predicted groundwater concentrations and Region 9 PRGs/MCLs for manganese, 2,4-DNT and beta-BHC, indicating that leaching processes have already occurred.

- Predicted groundwater concentrations beneath Building FF19 exceed Region 9 Residential PRGs/MCLs for antimony, chromium, and manganese. Observed groundwater concentrations exceed predicted concentrations and Region 9 Residential PRGs/MCLs for 2,4-DNT; RDX; and beta-BHC, indicating that leaching processes have already occurred.

- In the Team Track Area, leachate modeling predicted groundwater concentrations that exceed Region 9 Residential PRGs/MCLs for antimony, chromium, manganese, nickel, 3-nitrotoluene, 4-nitrotoluene, and nitrobenzene. Downgradient concentrations of 2,4-DNT; RDX; and beta-BHC exceed Region 9 Residential PRGs/MCLs, and predicted concentrations beneath the Team Track Area indicate that leaching processes have already occurred.

2.2.5.2 AT123D Modeling

AT123D modeling results indicate that offsite migration of some contaminants via groundwater pathways at Load Line 12 at concentrations above Region 9 Residential PRG/MCLs may occur in the future. Contaminants predicted to reach the Active Area Channel (groundwater baseflow discharge point within the AOC) at concentrations above Region 9 Residential PRGs/MCLs are:

- antimony; chromium; manganese; 2,4-DNT; RDX; and beta-BHC from Building FF19;
- RDX from Buildings 904 and 905; and
- chromium; manganese; 3-nitrotoluene; 2,4-DNT; and RDX from the Team Track Area.

Peak concentrations for metals are predicted to occur on the order of hundreds of years from the point of release. Peak concentrations for RDX are predicted to occur from about 40 years (Team Track Area) to 150 years (Buildings 904 and 905) from the point of release. Modeling of groundwater transport from source areas to the AOC boundary shows that RDX is predicted to reach the AOC boundary at concentrations above Region 9 Residential PRGs/MCLs from Buildings 904 and 905, with peak concentrations occurring about 150 years following the release point. However, a refined assessment of contaminant fate and transport demonstrated that, based on modeled timeframes to attain peak leaching concentrations and on actual observed groundwater concentrations, none of the constituents identified as contaminant migration constituents of concern (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

Load Line 12 Phase I data were not used in the Human Health Risk Assessment (HHRA) due to the extensive demolition activities that resulted in sampling sites being covered over, regraded, and possibly cross-contaminated. The potentially contaminated media are surface (0-1 ft BGS) and subsurface (1-7 ft BGS) soil, surface water, groundwater, and sediment. Load Line 12 is not currently used for OHARNG training purposes, there are no facilities requiring maintenance or security checks, and there are no groundskeeping activities. Maintenance workers visit infrequently to evaluate the status of the beaver dams. Security Guard/Maintenance Worker, Hunter/Trapper, Juvenile Trespasser (identified as a Child Trespasser in the RI report), National Guard Trainee, Open Recreator [called an Adult Trespasser in the Facility-wide Human Health Risk Assessor's Manual (FWHHRAM)], Open Industrial Worker, and Resident Farmer (adult and child) were chosen as receptors to reflect several different potential land use scenarios.

Potential human health risks/hazards were evaluated for exposure to constituent of potential concern (COPCs) in soil at two exposure units (EUs): Eastern Soil Aggregate and Western Soil Aggregate. Soil at Load Line 12 was evaluated as two EUs: Eastern Soil Aggregate and Western Soil Aggregate.

Constituents of concern (COCs) for soil for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for each soil EU below.

Eastern Soil Aggregate:

- No COCs were identified in surface soil (0-1 ft BGS) for the National Guard Trainee.

- One COC [benzo(a)pyrene] was identified in surface soil (0-1 ft BGS) for the Resident Subsistence Farmer at the Eastern Soil Aggregate.

- No COCs were identified in subsurface soil (1-7 ft BGS) at the Eastern Soil Aggregate.

Western Soil Aggregate:

- Two non-carcinogenic COCs (aluminum and manganese) were identified for the National Guard Trainee. Seven carcinogenic COCs were identified for this receptor including: one metal (arsenic), one PCB (Aroclor-1260), one explosive (2,4,6-TNT), and four SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene].

- One non-carcinogenic COC (2,4,6-TNT) was identified for the Resident Subsistence Farmer for surface soil (0-1 ft BGS) at the Western Soil Aggregate. Ten carcinogenic COCs were identified in surface soil for this receptor including: one metal (arsenic), one PCB (Aroclor-1260), three explosives (2,4,6-TNT; 2,6- DNT; and RDX), and five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

- No non-carcinogenic COCs were identified for the Resident Subsistence Farmer for subsurface soil (1-7 ft BGS) at the Western Soil Aggregate. Six carcinogenic COCs were identified in subsurface soil for this receptor including: one metal (arsenic), and five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

A subset of these COCs were identified for the other receptors evaluated.

Exposure to surface water and sediment was evaluated for six receptor scenarios: Juvenile Trespasser (identified as a Child Trespasser in the RI report), Hunter/Trapper, National Guard Trainee, Adult Trespasser (identified as an Adult Recreator in the RI report), and Onsite Resident Farmer (adult and child). Surface water and sediment at Load Line 12 were evaluated as four EUs: Active Area Channel, Main Ditch, North of Active Area, and West Ditches. COCs for surface water and sediment for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for each of these EUs below.

Active Area Channel:

- No sediment or surface water COCs were identified for the National Guard Trainee.

- Two sediment COCs [silver and benzo(a)pyrene] and seven surface water COCs (manganese; nitrate; silver; 2,4,6-TNT; 2,4-DNT; 2,6-DNT; and RDX) were identified for the Resident Subsistence Farmer at the Active Area Channel.

Main Ditch:

- Three sediment [arsenic, Aroclor-1254, and benzo(a)pyrene] and no surface water COCs were identified for the National Guard Trainee.

- Four sediment COCs [arsenic, Aroclor-1016, Aroclor-1254, and benzo(a)pyrene] and two surface water COCs (manganese and 2,4-DNT) were identified for the Resident Subsistence Farmer at the Main Ditch.

North of Active Area:

- No sediment COCs and two surface water COCs [arsenic and bis(2-ethylhexyl)phthalate] were identified for the National Guard Trainee.

- One sediment COC [benzo(a)pyrene] and three surface water COCs [arsenic, bis(2-ethylhexyl)phthalate, and 2,4-DNT] were identified for the Resident Subsistence Farmer North of the Active Area.

West Ditches:

- No COCs were identified in sediment or surface water for the National Guard Trainee.

- Two sediment COCs [arsenic and benzo(a)pyrene] and one surface water COC (manganese) were identified for the Resident Subsistence Farmer for the West Ditches.

Risks and hazards were estimated for the National Guard Trainee and Onsite Residential Farmer scenarios for potable use of groundwater. These are hypothetical future scenarios; no receptors are currently using groundwater from the AOC for any purpose. A summary of the results for groundwater follows:

- Four groundwater COCs [arsenic, aldrin, bis(2-ethylhexyl)phthalate, and 2-nitrotoluene] were identified for the National Guard Trainee at Load Line 12.

- Eight groundwater COCs [arsenic; manganese; nitrate; thallium; aldrin; bis(2-ethylhexyl)phthalate; 2,4-DNT; and 2-nitrotoluene] were identified for the Resident Subsistence Farmer (adult and child).

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

Table 2-1. Summary of HHRA Risk Results for Direct Contact at Load Line 12

Receptor	Total HI	Total ILCR	COCs	Notes
		National Guard Trainee (Representative Receptor)		
Surface Soil Eastern Aggregate Western Aggregate	 0.0019 5.5	 3.0E-07 3.1E-05	 None Al, As, Mn, TNT, PAHs[a], Aroclor-1260	East: Below USEPA and Ohio EPA target risk values. West: HQ > 1 for Al and Man inhalation. Exceeds USEPA and Ohio EPA target risk. Primary risk driver is B(a)P, risk from other COCs is below Ohio EPA target risk
Subsurface Soil[b]	0.0091	1.9E-06	None	Exceeds USEPA *de minimis* risk but below Ohio EPA target risk
Sediment Active Area Channel Main Ditch North of Active Area Upgradient West Ditches	 0.0076 0.23 0.00098 0.0012 0.0078	 1.2E-07 1.8E-05 1.7E-07 4.8E-06 7.7E-07	 None As, Aroclor-1254 None B(*a*)P None	AAC, NAA, WD: Below USEPA and Ohio EPA target risk values UG: Exceeds USEPA *de minimis* risk but below Ohio EPA MD: Exceeds USEPA and Ohio EPA target risk. Primary risk driver is As, risk from Aroclor is below Ohio EPA target risk
Surface Water Active Area Channel Main Ditch North of Active Area Upgradient West Ditches	 0.21 0.14 0.090 0.024 0.14	 5.1E-07 5.6E-08 5.2E-06 1.7E-08 2.5E-08	 None None As, BEHP None None	AAC, MD, UG, WD: Below USEPA and Ohio EPA target risk values NAA: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk
Groundwater	2.5	2.2E-04	As, 2-Nitrotoluene, Aldrin, BEHP	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from other COCs are below Ohio EPA target risk
		Industrial Worker		
Surface Soil Eastern Aggregate Western Aggregate	 0.0075 0.70	 4.0E-07 4/0E-05	 None As, TNT, PAHs[a], Aroclor-1260	East: Below USEPA and Ohio EPA target risk values. West: Exceeds USEPA and Ohio EPA target risk. Primary risk driver is B(a)P, risk from other COCs is below Ohio EPA target risk
Subsurface Soil[b]	0.13	2.1E-05	As, B(*a*)P, D(*a*,*h*)A	Exceeds USEPA and Ohio EPA target risk
		Security Guard/Maintenance Worker		
Surface Soil Eastern Aggregate Western Aggregate	 0.00050 0.83	 8.4E-07 6.9E-05	 None As, Aroclor-1260, TNT, PAHs[a]	East: Below USEPA and Ohio EPA target risk values. West: Exceeds USEPA and Ohio EPA target risk. Primary risk drivers are B(a)P and D(*a*,*h*)A, risk from other COCs is below Ohio EPA target risk
		Child Trespasser		
Surface Soil Eastern Aggregate Western Aggregate	 0.00043 0.20	 7.6E-08 6.4E-06	 None B(*a*)P	East: Below USEPA and Ohio EPA target risk values. West: Exceeds USEPA *de minimis* risk but below Ohio EPA
Sediment Active Area Channel Main Ditch North of Active Area Upgradient West Ditches	 0.022 0.83 0.0014 0.0018 0.021	 2.0E-07 2.2E-05 2.8E-07 8.0E-06 9.6E-07	 None As, Aroclor-1254 None B(*a*)P None	AAC, NAA, WD: Below USEPA and Ohio EPA target risk values UG: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk MD: Exceeds USEPA and Ohio EPA target risk. Primary risk driver is As, risk from Aroclor is below Ohio EPA target risk

Table 2-1. Summary of HHRA Risk Results for Direct Contact at Load Line 12 (continued)

Receptor	Total HI	Total ILCR	COCs	Notes
Surface Water				
Active Area Channel	0.36	2.1E-07	None	AAC, MD, UG, WD: Below USEPA and Ohio EPA target risk values NAA: Exceeds USEPA *de minimis* risk but below Ohio EPA
Main Ditch	0.25	2.6E-08	None	
North of Active Area	0.16	3.7E-06	BEHP	
Upgradient	0.044	7.5E-09	None	
West Ditches	0.24	9.9E-09	None	
Hunter/Trapper				
Surface Soil				East: Below USEPA and Ohio EPA target risk values. West: Exceeds USEPA *de minimis* risk but below Ohio EPA
Eastern Aggregate	0.00024	6.8E-08	None	
Western Aggregate	0.065	5.8E-06	B(*a*)P	
Sediment				AAC, NAA, WD: Below USEPA and Ohio EPA target risk values UG: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk MD: Exceeds USEPA and Ohio EPA target risk. Primary risk driver is As, risk from Aroclor is below Ohio EPA target risk
Active Area Channel	0.0078	1.8E-07	None	
Main Ditch	0.26	2.3E-05	As, Aroclor-1254	
North of Active Area	0.00074	2.5E-07	None	
Upgradient	0.00092	7.1E-06	B(*a*)P	
West Ditches	0.0078	9.9E-07	None	
Surface Water				
Active Area Channel	0.17	4.9E-07	None	AAC, MD, UG, WD: Below USEPA and Ohio EPA target risk values NAA: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk
Main Ditch	0.11	5.4E-08	None	
North of Active Area	0.072	5.0E-06	As, BEHP	
Upgradient	0.020	1.6E-08	None	
West Ditches	0.11	2.4E-08	None	
Open Recreator				
Surface Soil				East: Below USEPA and Ohio EPA target risk values. West: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk
Eastern Aggregate	0.00010	5.4E-08	None	
Western Aggregate	0.048	4.5E-06	B(*a*)P	
Sediment				AAC, NAA, WD: Below USEPA and Ohio EPA target risk values UG: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk MD: Exceeds USEPA and Ohio EPA target risk Primary risk driver is As, risk from Aroclor is below Ohio EPA target risk
Active Area Channel	0.0052	1.4E-07	None	
Main Ditch	0.20	1.6E-05	As, Aroclor-1254	
North of Active Area	0.00036	2.0E-07	None	
Upgradient	0.00045	5.7E-06	B(*a*)P	
West Ditches	0.0051	6.8E-07	None	
Surface Water				
Active Area Channel	0.11	1.9E-07	None	AAC, MD, UG, WD: Below USEPA and Ohio EPA target risk values NAA: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk
Main Ditch	0.082	2.4E-08	None	
North of Active Area	0.053	3.6E-06	BEHP	
Upgradient	0.014	6.9E-09	None	
West Ditches	0.078	9.1E-09	None	
Resident Subsistence Farmer (Adult)				
Surface Soil				East: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk West: Exceeds USEPA and Ohio EPA target risk Primary risk drivers are As, B(a)P, and D(*a,h*)A, risk from other COCs is below Ohio EPA target risk
Eastern Aggregate	0.011	1.6E-06	B(a)P	
Western Aggregate	1.8	1.5E-04	As, Aroclor-1260, DNT, TNT, PAHs[a], RDX	
Subsurface Soil[b]	0.29	7.1E-05	As, PAHs[a]	Exceeds USEPA and Ohio EPA target risk
Sediment				AAC, NAA: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk MD, UG, WD: Exceeds USEPA and Ohio EPA target risk
Active Area Channel	0.25	4.3E-06	B(*a*)P	
Main Ditch	7.3	7.0E-04	As, Aroclor-1016, Aroclor-1254, B(*a*)P	
North of Active Area	0.031	6.1E-06	B(*a*)P	
Upgradient	0.039	1.7E-04	PAHs[a]	
West Ditches	0.26	3.0E-05	B(*a*)P	
Surface Water				
Active Area Channel	4.1	3.0E-05	Mn, TNT, DNT, RDX	UG: Below USEPA and Ohio EPA target risk values MD, WD: HQ > 1 for Man. Exceeds USEPA *de minimis* risk but below Ohio EPA target risk AAC, NAA: Exceeds USEPA and Ohio EPA target risk
Main Ditch	2.1	2.9E-06	Mn, DNT	
North of Active Area	1.2	1.0E-04	As, DNT, BEHP	
Upgradient	0.35	8.9E-07	None	

Table 2-1. Summary of HHRA Risk Results for Direct Contact at Load Line 12 (continued)

Receptor	Total HI	Total ILCR	COCs	Notes
West Ditches	2.2	1.5E-06	Mn	
Groundwater	9.6	1E-03	As, Mn, Nitrate, DNT, 2-Nitrotoluene, Aldrin, BEHP, RDX	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from 2-nitrotoluene, aldrin also exceed Ohio EPA target risk. Risk from other COCs are below Ohio EPA target risk
Resident Subsistence Farmer (Child)				
Surface Soil Eastern Aggregate Western Aggregate	 0.098 7.0	 7.5E-07 8.4E-05	 None As, Aroclor-1260, DNT, TNT, PAHs[a], RDX	East: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk West: Exceeds USEPA and Ohio EPA target risk Primary risk drivers are As, B(a)P, and D(*a,h*)A, risk from other COCs is below Ohio EPA target risk
Subsurface Soil[b]	1.5	4.7E-05	As, PAHs[a]	Exceeds USEPA and Ohio EPA target risk
Sediment Active Area Channel Main Ditch	 1.4 30	 2.0E-06 7.6E-04	 Ag, B(*a*)P As, Aroclor-1016,-1254, B(*a*)P	AAC, NAA: Exceeds USEPA *de minimis* risk but below Ohio EPA target risk MD, UG, WD: Exceeds USEPA and Ohio EPA target risk
North of Active Area Upgradient West Ditches	0.24 0.30 1.5	2.8E-06 7.9E-05 3.2E-05	B(*a*)P PAHs[a] As, B(*a*)P	
Surface Water Active Area Channel Main Ditch North of Active Area Upgradient West Ditches	 14 7.3 4.1 1.2 7.6	 2.1E-05 2.0E-06 6.9E-05 6.2E-07 1.0E-06	 Mn, Nitrate, Ag, TNT, DNT, RDX Mn, DNT As, Mn, BEHP Mn Mn	UG: Below USEPA and Ohio EPA target risk values MD, WD: HQ > 1 for Man. Exceeds USEPA *de minimis* risk but below Ohio EPA target risk AAC, NAA: Exceeds USEPA and Ohio EPA target risk
Groundwater	33	7.0E-04	As, Mn, Nitrate, Tl, DNT, 2-Nitrotoluene, Aldrin, BEHP	Exceeds USEPA and Ohio EPA target risk. Primary risk driver is arsenic. Risk from 2-nitrotoluene, aldrin also exceed Ohio EPA target risk. Risk from other COCs are below Ohio EPA target risk

Chemical abbreviations:
- Ag = Silver.
- Al = Aluminum.
- As = Arsenic.
- B(*a*)P = Benzo(*a*)pyrene.
- BEHP = Bis(2-ethylhexyl)phthalate.
- D(*a,h*)A = Dibenz(*a,h*)anthracene.
- DNT = 2,4- and/or 2,6-Dinitrotoluene.
- Mn = Manganese.
- Tl = Thallium.
- TNT = 2,4,6-Trinitrotoluene.

Sediment/Surface Water Exposure Units:
- AAC = Active Area Channel.
- MD = Main Ditch.
- NAA = North of Active Area.
- UG = Upgradient.
- WD = West Ditches.

COC = Constituent of concern.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
PAH = Polynuclear aromatic hydrocarbon.
[a]PAH COCs for Security Guard/Maintenance Worker, National Guard Trainee, and Resident Subsistence Farmer = Benz(*a*)anthracene, benzo(*a*)pyrene, benzo(*b*)fluoranthene, dibenz(*a,h*)anthracene, and indeno(1,2,3-cd)pyrene (except National Guard Trainee).
[b]Subsurface soil evaluated for Western Aggregate only.

2.2.7 Ecological Risk Assessment

The Screening Ecological Risk Assessment (SERA) process provides an evaluation of the potential for risk to ecological receptors. This evaluation is considered to be conservative for two reasons: (1) maximum detected concentrations (MDCs) are compared to ecological screening values (ESVs) as opposed to 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 Load Line 12. Chemicals with no ESV are also retained as constituents 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.

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

Habitats at Load Line 12 include forests, grasslands, herbaceous fields, and wetlands. There are four drainage ditches at Load Line 12, which receive stormwater runoff from the surrounding area as well as Load Line 12. There are also two unnamed ponds within the AOC. Two of the ditches and the smaller of the unnamed ponds contain water year-round. These habitats support a variety of wildlife, including small mammals, birds, fish, and insects. There are a few state-threatened species and state-listed species of concern at RVAAP, but none have been documented at Load Line 12.

A frequency of detection analysis was used to eliminate chemicals of interest that were detected in 5% or less of the samples for a given medium. Chemicals that failed this analysis but were present in multiple media, or were PBT, were not eliminated. A media evaluation was performed to determine whether SRCs have impacted media associated with the AOC. Compounds that exceeded background concentrations or were PBT compounds were deemed COPECs. The COPECs were then screened for impact on the media at the AOC.

An ecological conceptual site model (CSM) was used to depict the stressors, pathways, and receptors at Load Line 12. The COPECs retained from the media screening were considered the AOC stressors. The exposure media were determined to be soil, surface water, and sediment. Ecological receptors include terrestrial plants, earthworms, deer mice, white-tailed deer, short-tailed shrews, American robins, red foxes, barn owls, benthic invertebrates, aquatic biota, mallard ducks, mink, and great blue herons. COECs were retained for soil, sediment, and surface water as presented in Table 2-2.

Table 2-2. Load Line 12 Soil, Sediment, and Surface Water COECs

Exposure Unit	HQs>1
Soil Ecological COECs	
Western Aggregate	15 metals, dieldrin, 2,4,6-TNT
Eastern Aggregate	5 metals
Sediment Ecological COECs	
Active Area Channel	6 metals
Main Ditch	metals, gamma-chlordane, 4,4'-DDE, PAHs, SVOCs
West Ditches	8 metals, SVOCs, heptachlor epoxide
North of Active Area	4 metals, SVOCs, 1,3-DNB
Surface Water Ecological COECs	
Active Area Channel	8 metals, 2,4,6-TNT
Main Ditch	3 metals
West Ditches	6 metals
North of Active Area	4 metals

COEC = Constituent of ecological concern.
DDE = 1,1-Dichloro-2,2-bis(p-chlorophenyl) ethylene.
DNB = Dinitrobenzene.
PAH = Polyaromatic hydrocarbons.
SVOCs = Semi-volatile organic compounds.
TNT = Trinitrotoluene.

The BERA (Level III Baseline) identified multiple COECs (labeled COPECs in their report) in surface soil (0-1 ft BGS) from the Western and Eastern Soil Aggregates at Load Line 12 (USACE 2004a). Surface soil COECs have the potential to pose a hazard to plants and animals.

For the Western Aggregate, 15 metals plus 1 pesticide (dieldrin) and 1 explosive (2,4,6-TNT) comprised the COECs. There were multiple COECs with large HQs identified for multiple receptors, and multiple COPECs with HQs > 1 for multiple receptors (Table 2-3). For example, iron, aluminum, and lead had large HQs. The largest HQ was 2,640 for iron for plants, followed by HQ = 1,210 for aluminum for shrews, and HQ = 434 for lead for robins. Aluminum had an HQ > 1 for six receptors (shrew, plant, mouse, robin, deer, and fox), which was the most receptors among all the COECs. Aluminum had an HQ >100 for plants (492) and mice (160). The HQ for chromium for earthworms (103) was also large. Several other metals (arsenic, antimony, cadmium, chromium, copper, lead, mercury, vanadium, and zinc), as well as dieldrin and 2,4,6-TNT had HQs > 1 for more than one ecological receptor. The remainder of the metals (manganese, nickel, selenium, and thallium) had an HQ > 1 for a single receptor. Note that aluminum and iron have reduced bioavailability and will be dropped (see Table 2-3).

For the Eastern Aggregate, there were far fewer COECs with mostly lower HQs, which included just five metals (iron, chromium, aluminum, vanadium, and zinc) (Table 2-3). Similar to the Western Aggregate, iron had the largest HQ (2130) for plants. Chromium had the next highest HQ (43) for earthworms, followed by the HQ for aluminum (12) for plants. In contrast to the Western Aggregate, there were not multiple COECs with large HQs and aluminum only had one HQ > 1. There were no HQs between 100 and 999, whereas the Western Aggregate has four such HQs. Vanadium and zinc each had HQs > 1 for three receptors, whereas chromium had just two HQs > 1. Note that aluminum and iron have reduced bioavailability and will be dropped (see Table 2-3).

In summary, both the Western Aggregate and Eastern Aggregate had multiple COECs with HQs > 1 for multiple ecological receptors. The Western Aggregate had substantially more COECs (15 metals plus a pesticide and an explosive) compared to the Eastern Aggregate's five metals. Iron had the highest HQs (> 2,000 for plants) at both aggregates. Aluminum had the next highest HQs for receptors at the Western Aggregate, whereas chromium had the next highest HQ for earthworms at the Eastern Aggregate. Although some of the HQs likely overestimate the risk of their COECs to ecological receptors due to low availability of the chemicals for biological uptake from soil (e.g., aluminum) or low confidence in the TRVs (e.g., iron for plants), the presence of multiple COECs with HQs > 1 for multiple receptors indicates the potential for adverse effects to ecological receptors from these chemicals in Load Line 12 surface soil (0-1 ft BGS).

The BERA (Level III Baseline) identified multiple COECs (and labeled COPECs in the RI Report) in sediment and surface water from four EUs within the Load Line 12 AOC that included (1) Active Area Channel Aggregate, (2) Main Ditch Aggregate, (3) West Ditches Aggregate, and (4) North of Active Area Aggregate (USACE 2004a). The receptors for sediment exposure included sediment-dwelling invertebrates and mink, whereas the receptors for exposure to surface water included aquatic biota, mink, herons, and mallard ducks. This summary focuses on the ecological risks in the two most downstream Aggregates: West Ditches and the North of Active Area. It is assumed that sediment and surface water COECs have accumulated downstream in the watershed and have the potential to pose a hazard or risk to animals.

Table 2-3. Overview of Surface Soil (0-1 ft BGS) COECs at Load Line 12 – BERA (Level III)

Exposure Unit	COECs with the 3 Highest HQs		Other COECs with HQs > 1	
	COEC	HQs	COEC	Range of HQs
Western Aggregate	Iron[a]	2640	Chromium	12 to 103
	Aluminum[b]	1210	2,4,6-TNT	2 to 31
	Lead	434	Zinc	1 to 29
			Vanadium	1 to 14
			Copper	3 to 10
			Arsenic	1 to 7
			Cadmium	3 to 6
			Thallium	5
			Mercury	1 to 4
			Antimony	1 to 3
			Manganese	2
			Nickel	2
			Selenium	1
			Dieldrin	1
Eastern Aggregate	Iron[a]	2130	Vanadium	1 to 12
	Chromium	43	Zinc	2 to 8
	Aluminum[b]	17		

COECs = Constituents of ecological concern [called COPECs in Load Line 12 Remedial Investigation (USACE 2004a)].
COPECs = Constituents of potential ecological concern.
Note: The HQs are based on Lowest Observed Adverse Effect Levels for plants and invertebrates, but No Observed Adverse Effect Levels for wildlife.
HQs = Hazard quotients.
Note that chemicals without TRVs were not considered COECs and were addressed in the uncertainty section of the RI Report.

[a] Iron is being dropped because it is bound up in the rock found at RVAAP and is not biologically available.
[b] Aluminum is being dropped because soil pH at RVAAP is usually around 7.

Sediment. For the West Ditches Aggregate sediment and sediment-dwelling biota, eight metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc), three SVOCs (2-methynaphthalene, naphthalene, and pyrene), and one pesticide (heptachlor epoxide) comprised the COECs by virtue of having an HQ exceeding 1. There were multiple COECs with large HQs (Table 2-4). The largest HQ was 27 for 2-methylnaphthalene, followed by those for copper (15) and heptachlor epoxide (13). For mink exposed to sediment at this Aggregate, no HQs exceeded 1.

For the North of Active Area Aggregate sediment and sediment-dwelling biota, four metals (cadmium, copper, silver, and zinc), five SVOCs [benzo(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, and pyrene], and one explosive (1,3-DNB) comprised the COECs based on having an HQ exceeding 1 for a receptor (Table 2-4). The explosive, 1,3-DNB had the largest HQ (64), followed by the HQ (55) for silver and zinc (4). Two metals (cadmium and copper) and the five SVOCs all had HQs between 1 and 9. For mink exposed to sediment at this Aggregate, no HQs exceeded 1.

Among the other three sediment Aggregates, cyanide had the highest HQ (28,000) followed by silver (794), both at the Active Area Aggregate (Table 2-4). The Upgradient Aggregate had 13 SVOCs (all polyaromatic hydrocarbons) whose HQs ranged from 7 to 107, whereas only a few of those SVOCs had HQs greater than 1 at any of the other four Aggregates (and none at the Active Area Aggregate). Seven metals had HQs exceeding 1 at the Main Ditch Aggregate, all of which also exceeded 1 at the next downstream Aggregate, the West Ditch Aggregate.

Surface Water. For the West Ditches Aggregate surface water, the three largest HQs were for aquatic biota (aluminum HQ = 82, barium HQ = 30, and iron HQ = 22 (Table 2-4). Three other inorganics (copper, zinc, and manganese) had HQs ranging between 1 and 9. Aluminum was the only COEC whose HQ (3) exceeded 1 for mink, while no HQs exceeded 1 for herons.

For the North of Active Area Aggregate, the three largest HQs were for aquatic biota (aluminum HQ = 28, barium HQ = 22, and iron HQ = 10 (Table 2-4). Silver was the only other COEC whose HQ (5) exceeded 1 for any receptor.

Among the other three surface water Aggregates, the Active Area Aggregate had the most COECs based on HQs exceeding 1 (eight inorganics and one explosive) (Table 2-4). Aluminum had the highest HQ (79), followed by silver (66) and barium (28), all for aquatic biota. The Main Ditch Aggregate only had three HQs whose HQs exceeded 1 [barium (28), manganese (3), and zinc (1)]. The Upgradient Aggregate had no COECs with an HQ greater than 1.

Thus, there is sufficient evidence to indicate the potential for adverse ecological effects to occur from the sediment and surface water COECs at Load Line 12 due to the presence of multiple COECs with HQs > 1 for at least one receptor in all five EUs, and particularly the two most downstream ones. However, the risks from some of these COECs are likely overestimated. For example, maximum bioaccumulation and bioconcentration factors from the literature were used in the assessment, which constitute conservative assumptions. In addition, the bioavailability of metals in sediment is likely lower than the total measured concentrations as indicated for aluminum in soils at RVAAP. Furthermore, the metal concentrations in the surface water were total concentrations, which likely overestimate the bioavailable fraction, which is represented by the usually lower dissolved concentration.

In summary, multiple COECs in both the sediments and surface waters had HQs exceeding 1 for at least one receptor at all five Aggregates except for the Upgradient surface water, which had none. Sediments from the West Ditch and North of Active Area (two most downstream Aggregates) had 12 and 10 HQs exceeding 1, respectively. Among the other three Aggregates, the Active Area had the highest HQs [cyanide (28,000) and silver (794)], whereas the Upgradient Aggregate had the most COECs with HQs exceeding 1 (17, 12 of which were SVOCs). Surface water from West Ditch and North of Active Area had their highest HQs for aluminum (82 and 28, respectively), barium (30 and 22, respectively), and iron (22 and 10, respectively). Among the other three EUs, the Active Area had the most HQs exceeding 1 (nine, including eight inorganics and one explosive), whereas the Upgradient EU had no HQs exceeding 1. Some of the HQs likely overestimate the risk as explained above. However, the presence of multiple COECs with HQs > 1 for multiple receptors indicates the potential for adverse effects to ecological receptors from these chemicals in Load Line 12 sediment and surface water.

Table 2-4. Overview of Sediment and Surface Water COECs at the Two Most Downstream Exposure Units at Load Line 12 – BERA (Level III)

Exposure Unit and Media	COECs with the 3 Highest HQs		Other COECs with HQs > 1	
	COEC	HQ	COEC	HQs
Sediment				
West Ditches	2-Methylnaphthalene	27	Mercury	9
	Copper	15	Zinc	4
	Heptachlor Epoxide	13	Arsenic	2
			Cadmium	2
			Lead	2
			Naphthalene	2
			Chromium	1
			Nickel	1
			Pyrene	1
North of Active Area	1,3-Dinitrobenzene	64	Cadmium	1
	Silver	55	Copper	1
	Zinc	4	5 SVOCs[a]	1
Surface Water				
West Ditches	Aluminum	82	Copper	4
	Barium	30	Zinc	4
	Iron	22	Manganese	3
North of Active Area	Aluminum	28	Silver	5
	Barium	22		
	Iron	10		

COECs = Constituent of ecological concern.
HQs = Hazard quotients based on NOAELs.
NOAELs = No observed adverse effect levels.
SVOCs = Semivolatile organic compounds.
[a]Includes benzo(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, chrysene, and pyrene.

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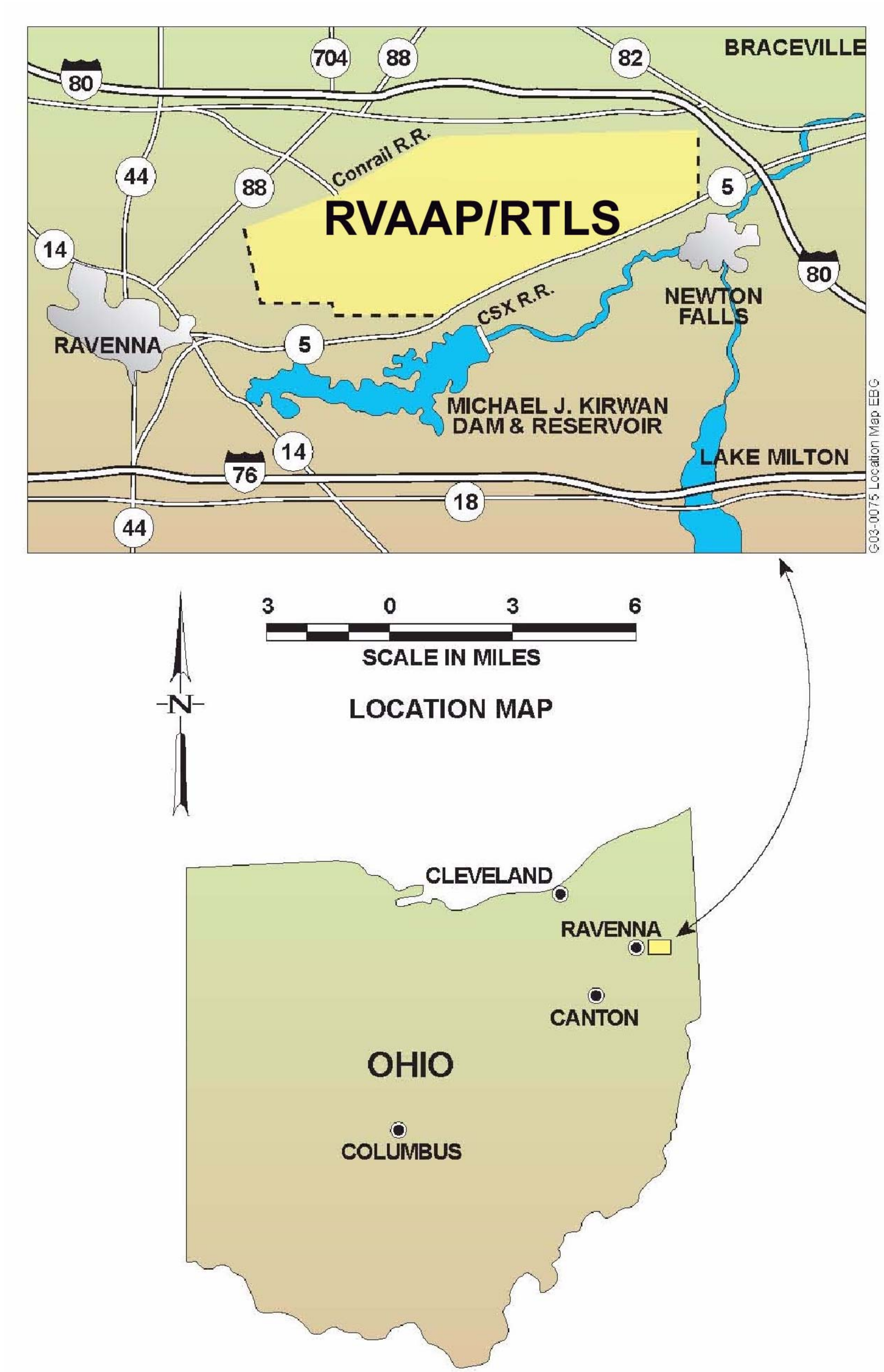

Figure 2-1. General Location and Orientation of RVAAP/RTLS

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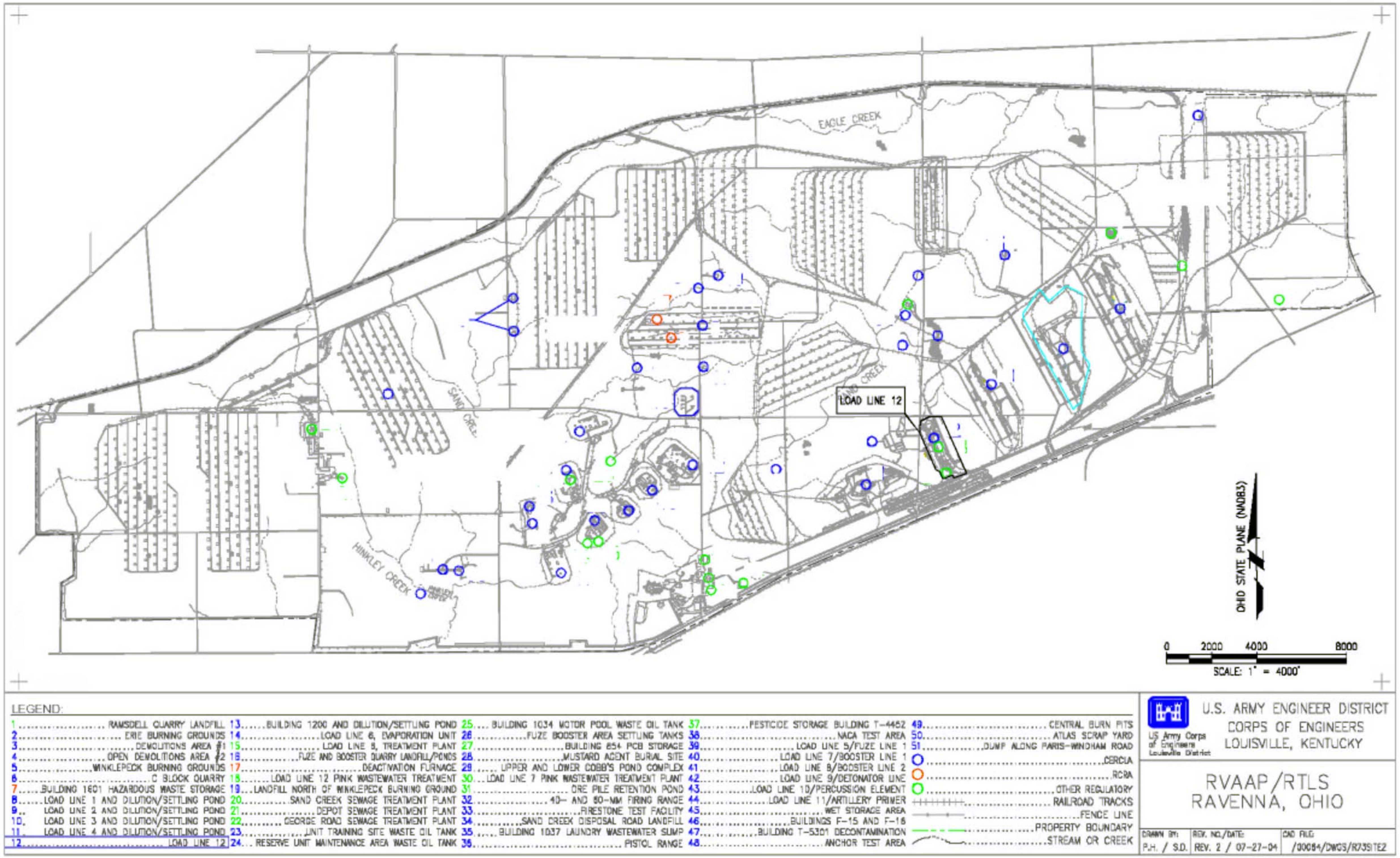

Figure 2-2. RVAAP/RTLS Installation Map

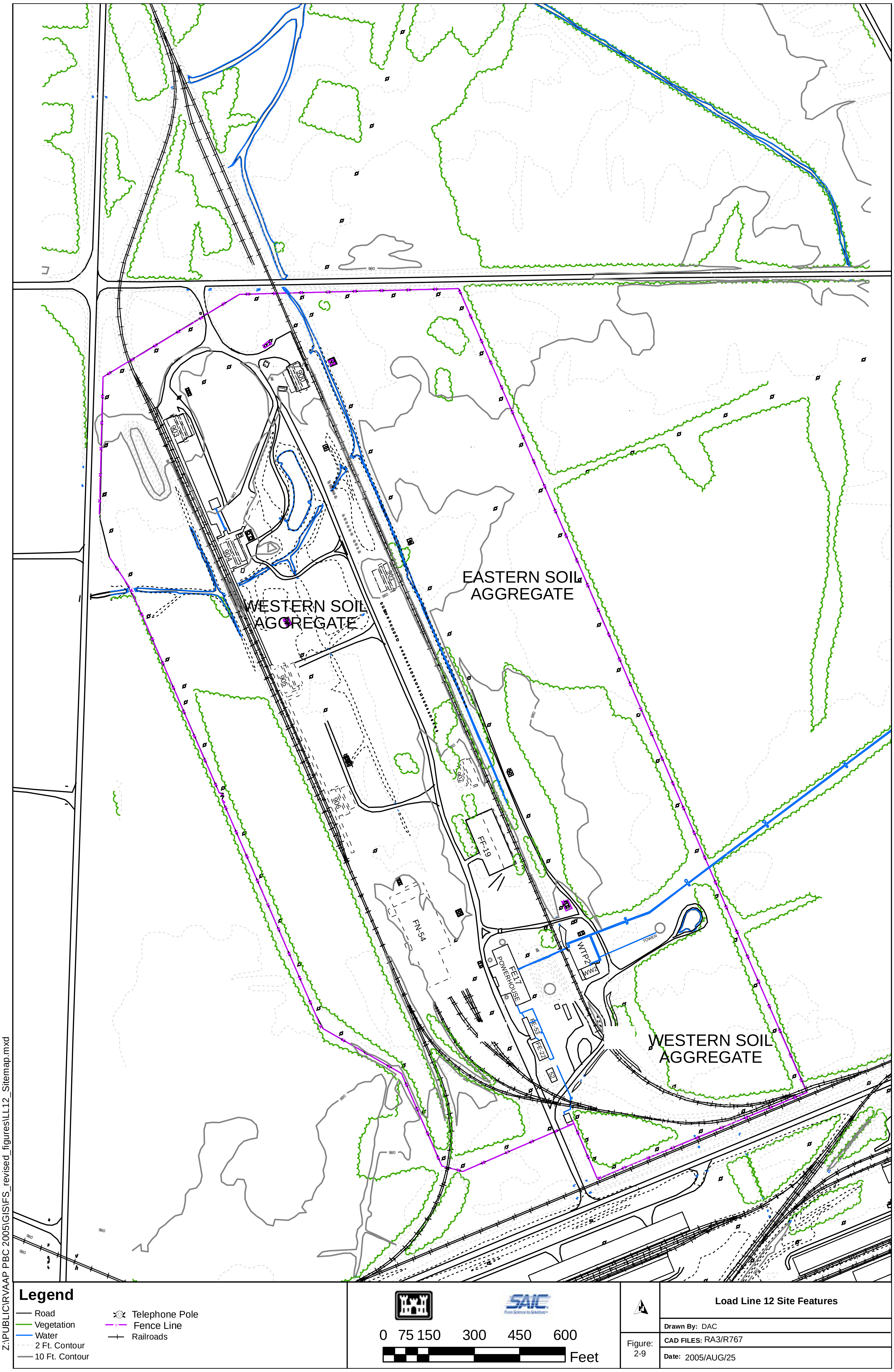

Figure 2-3. Features of Load Line 12

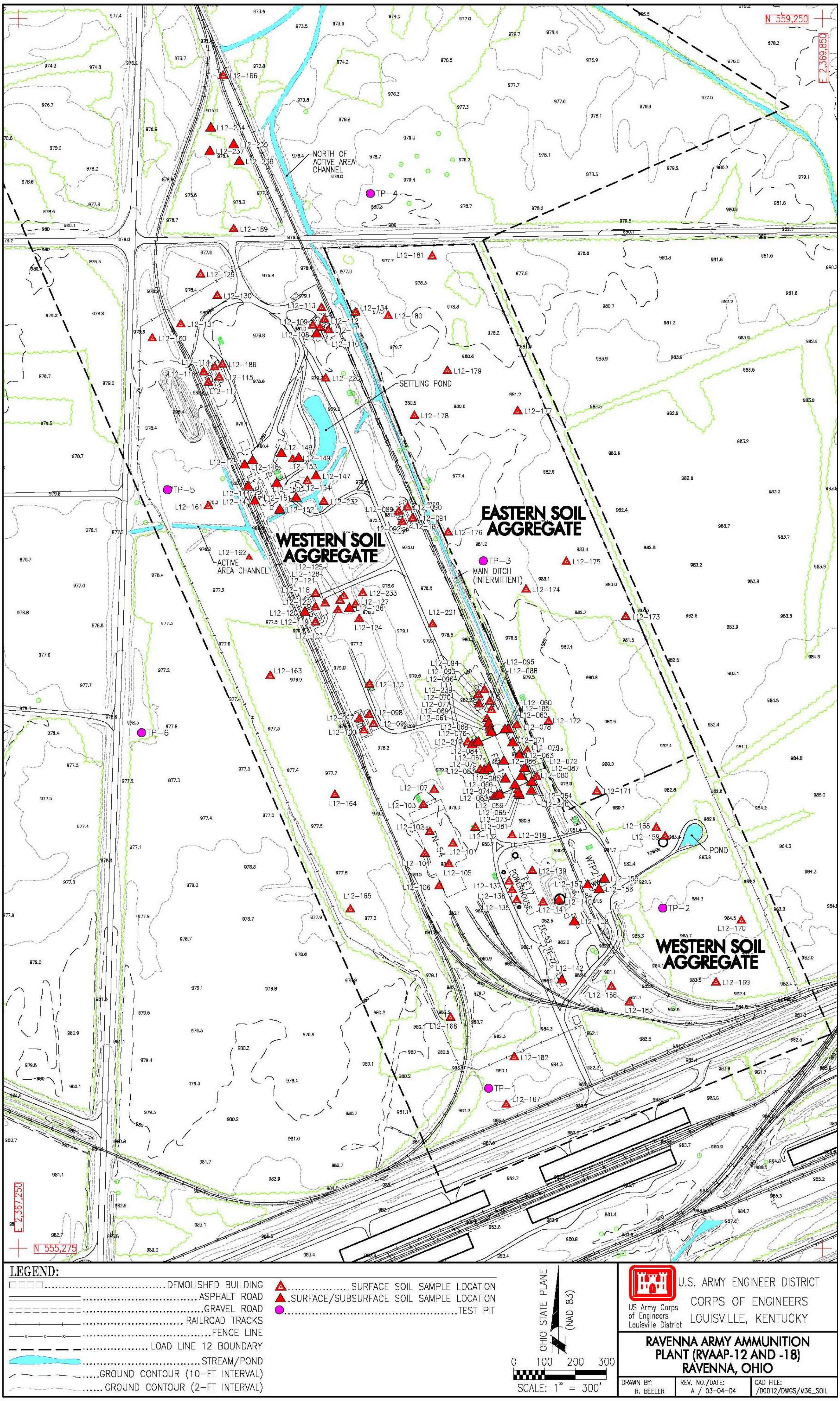

Figure 2-4. Soil Sample Locations at Load Line 12

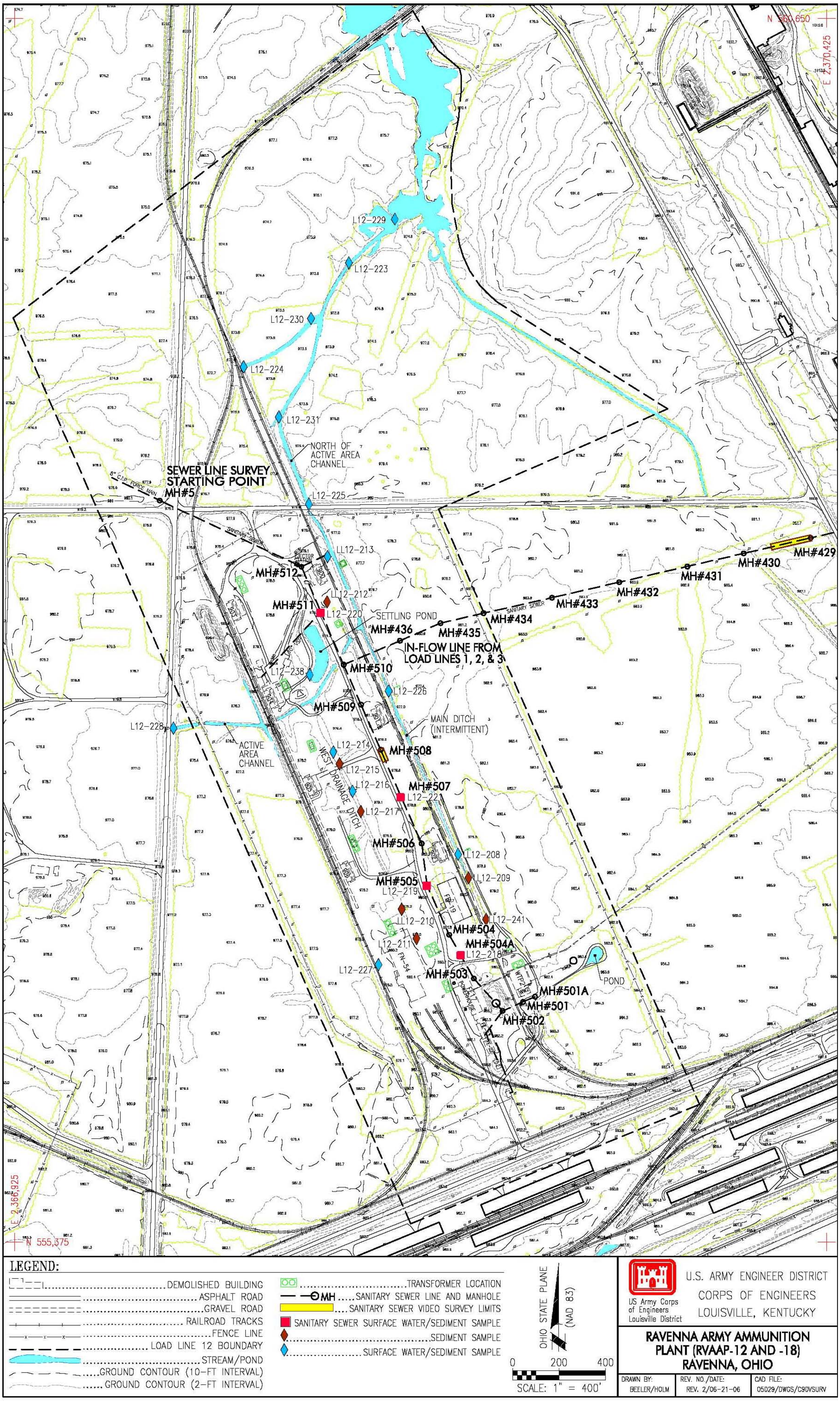

Figure 2-5. Sediment/Surface Water Sample Locations at Load Line 12

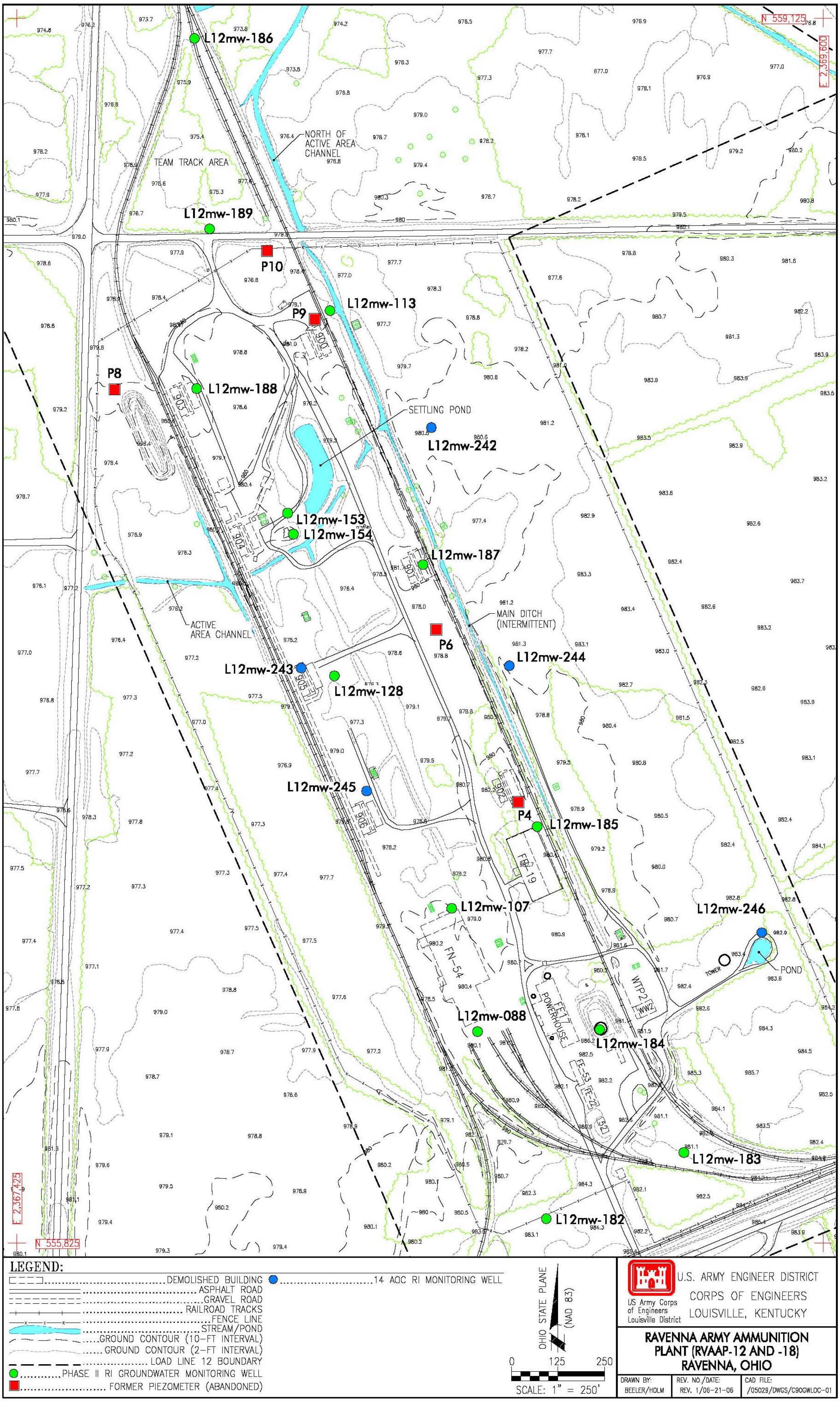

Figure 2-6. Monitoring Well Locations at Load Line 12

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3.0 REMEDIAL ACTION OBJECTIVES

This chapter of the FS describes the RAO for Load Line 12. 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 Chapters 5, 6, and 7. The primary objectives of this chapter are:

1. To present the RAO for Load Line 12.
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 the RAO.
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 for remedial alternatives to meet this RAO are presented in Section 3.3.
- Ecological weight-of-evidence for meeting the RAO are 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 from the information presented in Sections 3.1 through 3.4 is presented in Section 3.6.
- The extent and volume of impacted soils/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 Load Line 12. To provide this protection, media-specific objectives that identify major contaminants and associated media-specific cleanup goals are developed. These objectives specify COCs, exposure routes and receptors, and acceptable constituent concentrations for long-term protection of receptors. The baseline HHRA conducted for Load Line 12 is summarized in Chapter 2 of this FS and detailed in Chapters 6 and 7 of the Phase II RI Report (USACE 2004a).

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 Load Line 12.

Table 3-1. Land Use Scenarios Assessed in the Load Line 12 FS

AOC	Land Use Scenario	Receptor
Load Line 12	Restricted	National Guard Trainee
	Residential	Resident Subsistence Farmer

Land use at Load Line 12 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 this AOC may be eligible for unrestricted release; however, Load Line 12 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. Other receptors, in addition to the representative receptor and Resident Subsistence Farmer, are evaluated in the baseline HHRA for Load Line 12. The representative receptor is protective of other activities that may occur under anticipated future land use.

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

The ecological risk assessment (ERA) performed for Load Line 12 identifies a variety of ecological receptor populations that could be at risk and identifies the 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 Load Line 12 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.

The necessary CERCLA remediation requirements with respect to soils and dry sediments will be performed to achieve remedy at Load Line 12. 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 Load Line 12.

- Prevent National Guard Trainee exposure to contaminants in soils and dry sediments that exceed risk-based cleanup goals to a depth of 4 ft BGS.

At Load Line 12, preliminary cleanup goals are developed for impacted environmental media including groundwater and surface water (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 National Resources Management Plan to address future use of RTLS property (OHARNG 2001). OHARNG has established future land use for Load Line 12 as Mounted Training, No Digging based on anticipated training mission and utilization of the RTLS (USACE 2004b). Future land use is discussed in more detail in Section 3.3.

3.3 IDENTIFICATION OF HUMAN HEALTH PRELIMINARY CLEANUP GOALS AT LOAD LINE 12

This section documents the proposed land use and corresponding preliminary cleanup goals to support the remedial alternative selection process for soil remediation at Load Line 12. Chemical-specific numeric cleanup goals are used to meet the remedial action objective for protection of human health.

The HHRA performed for Load Line 12 is available in the RI Report and summarized in Chapter 2 of this FS. The risk assessment included in the RI Report documents a variety of potential human receptor populations [e.g., National Guard Trainee, Security Guard/Maintenance Worker, Recreator, Industrial Worker, Trespasser, Hunter/Trapper, 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 at Load Line 12. This risk assessment 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 National Guard Trainee and Resident Subsistence Farmer land use from these risk-based cleanup goals, background concentrations, and other information in this section. Preliminary cleanup goals are established for a National Guard Trainee for likely future land use by OHARNG. The preliminary cleanup goals for the National Guard Trainee 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 National Guard Trainee are also protective of a hunter or a security guard). The potential for the National Guard Trainee to be protective of a trespasser to the AOCs also addressed. In addition to the National Guard Trainee, 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 unrestricted release; however, Load Line 12 is not currently a candidate for unrestricted release and will be transferred to NGB for subsequent licensing to OHARNG for military training.

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 and non-cancer reference doses) are provided in the HHRA and were taken from the FWHHRAM (USACE 2004b).

The FWHHRAM (USACE 2004b) 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 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 might be appropriate to select chemical-specific preliminary cleanup goals with a THI of 0.1 to account for exposure to multiple contaminants. AOC-specific TR and THI levels are established in Section 3.3.3.

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, the background concentration is selected as the preliminary cleanup goal.

The list of human health COCs for evaluation of remedial alternatives are identified for Load Line 12 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 Load Line 12 (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 (Section 3.3.5).

3.3.1 Land Use and Potential Receptors at Load Line 12

The intended future land use for Load Line 12 is for National Guard training. Specifically, this area will be used for mounted training. Per the FWHHRAM (USACE 2004b), mounted training would permit direct contact with soil and/or water up to 24 hrs/day, 24 days/year on inactive duty training and/or 24 hrs/day, 15 days/year during annual training. All digging is prohibited in this area. Digging and occupying fighting positions, tank defilade positions, tank ditches and battle positions that extend below ground surface are prohibited. Tracked and wheeled operations are permitted only as directed in Section 16 of Adjutant General of Ohio Pamphlet (Pam) 210-1. Maneuver damage may occur up to 4 ft BGS. This future use could include the three National Guard receptor types (Trainee, Security Guard/Maintenance Worker, and Fire/Dust Suppression Worker). The National Guard Trainee is exposed to soil through incidental ingestion, dermal contact, and inhalation of vapors and fugitive dust 24 hrs/day, 39 days/year for 25 years (for a total of 936 hrs/year). The other two National Guard receptors are exposed for much shorter periods of time [i.e., 4 hrs/day, 15 days/year (60 hrs/year) for 25 years for the fire/dust-suppression worker and 1 hr/day, 250 days/year (250 hrs/year) for 25 years for the security guard/maintenance worker]. Based on these parameter values, the National Guard Trainee produces the largest risks among the three National Guard receptors, and, therefore, preliminary cleanup goals established for this receptor will also be protective of other National Guard receptors. Based on this intended future land use, preliminary cleanup goals for the National Guard Trainee are presented here as the primary preliminary cleanup goals applicable to Load Line 12 soil.

While the intended future land use for Load Line 12 does not include recreational use, preliminary cleanup goals established for the National Guard Trainee 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 only 4.57 hrs/day, 7 days/year (32 hrs/year) for 30 years.

The intended future land use at Load Line 12 does not include commercial/industrial development. The National Guard Trainee has similarities to a commercial/industrial receptor (e.g., 25-year adult exposure). The total exposure time for an industrial worker (2,000 hrs/year) is approximately double that of the National Guard Trainee; however, exposure to airborne contaminants (i.e., fugitive dust) is greater for the National Guard Trainee because of high dust generation by tracked vehicles used in training. Based on this analysis, the National Guard Trainee would produce larger risks than the commercial/industrial receptor when assessing human health risks via inhalation; therefore, the National Guard Trainee would be protective of the commercial/industrial receptor exposed via the inhalation pathway. However, if commercial/industrial development is proposed in future land use planning, it will be necessary to re-evaluate potential receptors. The National Guard Trainee is also protective of a Juvenile Trespasser (identified as a Child Trespasser in the RI Report) who is assumed to visit the AOC 2 hrs/day, 50 days/year (100 hrs/year) for 10 years (compared to 936 hrs/year for 25 years for the National Guard Trainee) and an Adult Trespasser (identified as an Adult Recreator in the RI report) assumed to visit the AOC 2 hrs/day, 75 days/year (150 hrs/year) for 30 years (compared to 936 hrs/year for 25 years for the National Guard Trainee).

In addition to the representative receptor (National Guard Trainee) described above, the Resident Subsistence Farmer (adult and child) provides a baseline for evaluating whether this AOC may be eligible for unrestricted release; however, Load Line 12 is currently not a candidate for unrestricted release as it is being transferred to OHARNG. Planned training activities and MEC concerns will most likely preclude Load Line 12 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

COCs are defined as chemicals with an incremental lifetime cancer risk 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.

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

Soil at Load Line 12 was evaluated as two EUs: Eastern Soil Aggregate and Western Soil Aggregate. COCs for soil for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for each soil EU below.

Eastern Soil Aggregate:

- No COCs were identified in surface soil (0-1 ft BGS) for the National Guard Trainee.

- One COC [benzo(a)pyrene] was identified in surface soil for the Resident Subsistence Farmer at the Eastern Soil Aggregate.

- No COCs were identified in subsurface soil (1-7 ft BGS) at the Eastern Soil Aggregate.

Western Soil Aggregate:

- Two non-carcinogenic COCs (aluminum and manganese) were identified for the National Guard Trainee. Seven carcinogenic COCs were identified for this receptor including: one metal (arsenic), one PCB (Aroclor-1260), one explosive (2,4,6-TNT), and four SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene].

- One non-carcinogenic COC (2,4,6-TNT) was identified for the Resident Subsistence Farmer for surface soil (0-1 ft BGS) at the Western Soil Aggregate. Ten carcinogenic COCs were identified in surface soil for this receptor including: one metal (arsenic), one PCB (Aroclor-1260), three explosives (2,4,6-TNT; 2,6-DNT; and RDX), and five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

- No non-carcinogenic COCs were identified for the Resident Subsistence Farmer for subsurface soil (1-7 ft BGS) at the Western Soil Aggregate. Six carcinogenic COCs were identified in subsurface soil for this receptor including: one metal (arsenic), and five SVOCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene].

Dry sediment at Load Line 12 was evaluated as five EUs: Active Area Channel, Main Ditch, North of Active Area, Upgradient Location, and West Ditches. COCs for sediment for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for each sediment EU below.

Active Area Channel:

- No COCs were identified in sediment for the National Guard Trainee.

- Two COCs [silver and benzo(a)pyrene] were identified in sediment for the Resident Subsistence Farmer at the Active Area Channel.

Main Ditch:

- Three COCs [arsenic, Aroclor-1254, and benzo(a)pyrene] were identified in sediment for the National Guard Trainee.

- Four COCs [arsenic, Aroclor-1016, Aroclor-1254, and benzo(a)pyrene] were identified in sediment for the Resident Subsistence Farmer at the Main Ditch.

North of Active Area:

- No COCs were identified in sediment for the National Guard Trainee.

- One COC [benzo(a)pyrene] was identified in sediment for the Resident Subsistence Farmer North of the Active Area.

Upgradient Location:

- One COC [benzo(a)pyrene] was identified in sediment for the National Guard Trainee.

- Five COCs [benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene] were identified in sediment for the Resident Subsistence Farmer at the Upgradient Location.

West Ditches:

- No COCs were identified in sediment for the National Guard Trainee.

- Two COCs [arsenic and benzo(a)pyrene] were identified in sediment for the Resident Subsistence Farmer for the West Ditches.

A Trespasser Adult (identified as the Recreator in the RI Report) and Juvenile (identified as a Child Trespasser in the RI Report) was also evaluated at Load Line 12. A subset of the soil and sediment COCs identified for the National Guard Trainee were also identified for the Trespasser [i.e., benzo(*a*)pyrene in the Western Aggregate surface soil (0-1 ft BGS), arsenic and Arochlor-1254 in Main Ditch sediment, and benzo(*a*)pyrene in Upgradient sediment].

3.3.2.2 <u>COCs in Surface Water</u>

Surface Water at Load Line 12 was evaluated as five EUs: Active Area Channel, Main Ditch, North of Active Area, Upgradient Location, and West Ditches. COCs for sediment for the National Guard Trainee and Resident Subsistence Farmer (adult and child) are summarized for each sediment EU below.

Active Area Channel:

- No COCs were identified in surface water for the National Guard Trainee.

- Seven COCs (manganese; nitrate; silver; 2,4,6-TNT; 2,4-DNT; 2,6-DNT; and RDX) were identified in surface water for the Resident Subsistence Farmer at the Active Area Channel.

Main Ditch:

- No COCs were identified in surface water for the National Guard Trainee.

- Two COCs (manganese and 2,4-DNT) were identified in surface water for the Resident Subsistence Farmer at the Main Ditch.

North of Active Area:

- Two COCs [arsenic and bis(2-ethylhexyl)phthalate] were identified in surface water for the National Guard Trainee.

- Three COCs [arsenic, bis(2-ethylhexyl)phthalate, and 2,4-DNT] were identified in surface water for the Resident Subsistence Farmer North of the Active Area.

Upgradient Location:

- No COCs were identified in surface water for the National Guard Trainee.

- No COCs were identified in surface water for the Resident Subsistence Farmer at the Upgradient Location.

West Ditches:

- No COCs were identified in surface water for the National Guard Trainee.

- One COC (manganese) was identified in surface water for the Resident Subsistence Farmer for the West Ditches.

A subset of the surface water COCs identified for the National Guard Trainee were also identified for the Trespasser [i.e., benzo(a)pyrene North of Active Area].

3.3.2.3 <u>COCs in Groundwater</u>

Four groundwater COCs [arsenic, aldrin, bis(2-ethylhexyl)phthalate, and 2-nitrotoluene] were identified for the representative receptor (National Guard Trainee) at Load Line 12.

Eight groundwater COCs [arsenic; manganese; nitrate; thallium; aldrin; bis(2-ethylhexyl)phthalate; 2,4-DNT; and 2-nitrotoluene] were identified in the HHRA for the Resident Subsistence Farmer (adult and child).

3.3.3 Target Risk for Preliminary Cleanup Goals

The FWHHRAM (USACE 2004b) identifies a 1E-05 target for ILCR (TR) for carcinogens and an acceptable THI of 1 for non-carcinogens consistent with Ohio EPA guidance, with the caveat that exposure to multiple COCs might require these targets to be decreased. For example, if numerous (i.e., more than ten) 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 Load Line 12 are dependent on several factors, including the number of carcinogenic and non-carcinogenic COCs and the target organs and toxic endpoints of these COCs. A chemical-specific TR of 1E-05 and THI of 1.0 are identified as appropriate for establishing preliminary cleanup goals for soil at Load Line 12 based on the small number of COCs present and the types of COCs (carcinogenic or non-carcinogenic) as summarized below.

The National Guard Trainee is the representative receptor for Load Line 12. A maximum of nine soil COCs were identified for this receptor (at the Western Soil Aggregate): seven carcinogens and two non-carcinogens. Of the seven carcinogens, one (arsenic) is a class A carcinogen associated with lung tumors; four PAHs [benz(a)anthracene (stomach tumors), benzo(a)pyrene (larynx/stomach tumors), benzo(b)fluoranthene (tumors), and dibenz(a,h)anthracene (immunodepressive effects)] are class B2 carcinogens that might have some similarities in target organs (mostly stomach or undefined tumors); Aroclor-1260 is also a class B2 carcinogen, but with potential effects to the liver; 2,4,6-TNT is a class C carcinogen for bladder transitional cell papilloma. Of the two non-carcinogens (aluminum and manganese) only the toxic endpoint for manganese [central nervous system] is known.

A maximum of ten soil COCs were identified for the Resident Subsistence Farmer scenario (at the Western Soil Aggregate). All ten are carcinogenic (2,4,6-TNT has both carcinogenic and non-carcinogenic effects, but its risk-based preliminary cleanup goal is dominated by the non-carcinogenic effects). Of these ten COCs, one (arsenic) is a class A carcinogen associated with respiratory system tumors, five PAHs are class B2. Of these five PAHs two are associated with stomach tumors [benz(a)anthracene and benzo(a)pyrene], two are associated with general tumors [benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene], and one with immunodepressive effects [dibenz(a,h)anthracene]; Aroclor-1260 is also a class B2 carcinogen, but with potential effects to the liver; 2,6-DNT is also a class B2 carcinogen associated with liver carcinoma. RDX and 2,4,6-TNT are class C carcinogens for liver and bladder effects respectively.

Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 was identified as appropriate for establishing preliminary cleanup goals for soil at Load Line 12.

A maximum of three sediment COCs [arsenic, Aroclor-1254, and benzo(a)pyrene] were identified for the National Guard Trainee (at the Main Ditch). Arsenic and Aroclor-1254 are both carcinogen and non-carcinogen but the risk-based cleanup goals are dominated by their carcinogenic effects. Benzo(a)pyrene is only a carcinogen. Of these carcinogens, one (arsenic) is a class A carcinogen associated with lung tumors; and the other two [Aroclor-1254 and benzo(a)pyrene] are class B2 carcinogens, with potential effects to the liver and stomach tumors, respectively.

A maximum of five sediment COCs were identified for the Resident Subsistence Farmer scenario (at the Upgradient Location). All five COCs are class B2 carcinogenic PAHs; two are associated with stomach tumors [benz(a)anthracene and benzo(a)pyrene], two are associated with general tumors [benzo(b)fluoranthene and indeno(1,2,3-cd)pyrene], and one with immunodepressive effects [dibenz(a,h)anthracene]. Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 was identified as appropriate for establishing preliminary cleanup goals for sediment at Load Line 12.

A maximum of two surface water COCs (both carcinogens) were identified for the National Guard Trainee (North of Active Area Channel). A maximum of seven surface water COCs (three noncarcinogens, three carcinogens, and one COC with both noncarcinogenic and carcinogenic endpoints) were identified for the Resident Subsistence Farmer scenario (at the Active Area Channel). Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 was identified as appropriate for establishing preliminary cleanup goals for surface water at Load Line 12.

A maximum of four groundwater COCs (all carcinogens) were identified for the National Guard Trainee. A maximum of eight groundwater COCs (three noncarcinogens, four carcinogens, and one COC with both noncarcinogenic and carcinogenic endpoints) were identified for the Resident Subsistence Farmer scenario. Based on these results, a chemical-specific TR of 1E-05 and THI of 1.0 was identified as appropriate for establishing preliminary cleanup goals for groundwater at Load Line 12.

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 National Guard Trainee in Table 3-2.

The COCs listed in Table 3-2 were identified in the HHRA (USACE 2004a) conducted prior to publication of the FWHHRAM (USACE 2004b). As time progressed, OHARNG training regimens were refined and exposure assumptions for the National Guard Trainees were adjusted to better reflect the activities. The exposure frequency used for the National Guard Trainee exposure to soil (180 days/year) in the HHRA is larger than the exposure frequency of a National Guard Trainees as recommended in the FWHHRAM (1 weekend per month and 2 weeks per year for a total of 39 days/year). Exposure parameters recommended in the FWHHRAM were developed following land use recommendations for RVAAP in conjunction with OHARNG, Ohio EPA, and USACE to reflect estimates of exposure that are reasonable and protective for receptors at RVAAP based on most recent Ohio EPA and USEPA guidance. Therefore, while the HHRA provides a list of COCs based on previous parameters for this receptor (e.g., exposure to soil 180 days/year as opposed to 39 days/year), the risk-based cleanup goals listed in Table 3-2 are calculated for the National Guard Trainee receptor as defined in the FWHHRAM

(USACE 2004b) and taken from the Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4 (Shaw 2004).

The calculated risk-based cleanup goal for manganese (350 mg/kg) is less than both the background criterion (1,450 mg/kg) and the established USEPA Region 9 PRG concentration (1,800 mg/kg) for residential soils. As a result, the concentration of 1,800 mg/kg is used as the surface soil (0-1 ft BGS) preliminary cleanup goal for the National Guard Trainee. This approach is consistent with the approach used in the Focused FS for the Remediation of Soils at Load Lines 1 through 4 (Shaw 2005).

Table 3-2. Soil Preliminary Cleanup Goals for National Guard Trainee Scenario at Load Line 12

COC	EPC (mg/kg)		Risk-Based Cleanup Goal[a] (mg/kg)		Background[b] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
	East	West	HI = 1.0	ILCR = 1E-05		
Inorganics						
Aluminum	NA	24,600	34,942	--	17,700	34,942
Arsenic	NA	12.8	1,500	31	15.4	31
Manganese	NA	862	350	--	1,450	1,800[c]
Explosives						
2,4,6-Trinitrotoluene	NA	170	1,600	3,100	NA	1,600
Polychlorinated Biphenyls						
Aroclor-1260	NA	1.1	55[d]	35[d]	NA	35[d]
Semivolatiles						
Benz(a)anthracene	NA	2.9	--	100	NA	100
Benzo(a)pyrene	NA	2.5	--	10	NA	10
Benzo(b)fluoranthene	NA	2.9	--	100	NA	100
Dibenz(a,h)anthracene	NA	0.77	--	10	NA	10

[a] Values from the Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4 (Shaw 2004).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
[c] Value is EPA Region 9 residential PRG (http://www.epa.gov/region09/waste/ sfund/prg/index.html).
[d] Value is for Aroclor-1254.
-- = Toxic endpoint not evaluated for this COC.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Not a COC at this aggregate or background criteria only apply to inorganics.

No risk-based cleanup goal was available for Aroclor-1260 in the Proposed RGOs for Soil at Load Lines 1, 2, 3, and 4 (Shaw 2004); therefore, the value for Aroclor-1254 is used. These two Aroclors are both class B2 carcinogens (for liver tumors) and have the same dermal and gastrointestinal absorption values and the same cancer slope factors.

Estimated soil EPCs for all nine COCs are less than the soil preliminary cleanup goals established for these COCs for the National Guard Trainee Scenario.

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

The COCs listed in Table 3-3 were identified in the HHRA (USACE 2004a) conducted prior to publication of the FWHHRAM (USACE 2004b). As time progressed, OHARNG training regimens were refined and exposure assumptions for the National Guard Trainees were adjusted to better reflect the activities. The exposure frequency used for the National Guard Trainee exposure to sediment (28 days/year) in the HHRA is lower than the exposure frequency of a National Guard Trainees as recommended in the FWHHRAM (1 weekend per month and 2 weeks per year for a total of 39 days/year). As noted previously, exposure parameters recommended in the FWHHRAM were developed following land use recommendations for RVAAP in conjunction with OHARNG, Ohio EPA, and USACE to reflect estimates of exposure that are reasonable and protective for receptors at RVAAP. Therefore, while the HHRA provides the list of COCs based on previous parameters for this receptor (e.g., exposure to sediment 28 days/year as opposed to 39 days/year), the risk-based cleanup goals listed in Table 3-3 are calculated for the National Guard Trainee receptor as defined in the FWHHRAM (USACE 2004b) and taken from the Proposed RGOs for soil at Load Lines 1, 2, 3, and 4 (Shaw 2004).

Table 3-3. Sediment Preliminary Cleanup Goals for National Guard Trainee Scenario at Load Line 12

COC	EPC (mg/kg)		Risk-Based Cleanup Goal[a] (mg/kg)		Background[b] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
	MD	UL	HI = 1.0	ILCR = 1E-05		
Inorganics						
Arsenic	410	NA	1,500	31	20	31
Polychlorinated Biphenyls						
Aroclor-1254	11	NA	55	35	NA	35
Semivolatiles						
Benzo(a)pyrene	NA	4.4	--	10	NA	10

[a] Values from the Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4 (Shaw 2004).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
MD = Main Ditch exposure unit.
NA = Not applicable. Not a COC at this aggregate or background criteria only apply to inorganics.
UL = Upgradient Location exposure unit.

The estimated EPCs for Aroclor-1254 and benzo(a)pyrene are less than the preliminary cleanup goals established for these chemicals for the National Guard Trainee.

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 3-4 and 3-5, respectively.

Estimated surface soil (0-1 ft BGS) EPCs for arsenic, 2,6-DNT, RDX, Aroclor-1260, benz(a)anthracene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario. Estimated subsurface soil (1-7 ft BGS) EPCs for arsenic, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario.

Table 3-4. Soil Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at Load Line 12

COC	EPC[a] (mg/kg)		Risk-Based Cleanup Goal[b] (mg/kg)				Background[c]		Preliminary Cleanup Goal	
			Adult		Child					
	East	West	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05	Surface	Sub surface	Surface	Sub surface
Inorganics										
Arsenic	NA	12.8 (12.6)	130	6.7	22	5.7	15.4	19.8	15.4	19.8
Explosives										
2,4,6-Trinitrotoluene	NA	165	110	170	32	250	NA	NA	32	32
2,6-Dinitrotoluene	NA	1.7	220	7.6	64	11	NA	NA	7.6	7.6
RDX	NA	9.31	670	47	190	68	NA	NA	47	47
Polychlorinated Biphenyls										
Aroclor-1260	NA	1.09	3.5[d]	2.0[d]	1.2[d]	3.5[d]	NA	NA	1.2[d]	1.2[d]
Semivolatiles										
Benz(a)anthracene	NA	2.89 (1.21)	--	5.9	--	9.7	NA	NA	5.9	5.9
Benzo(a)pyrene	0.049	2.54 (1.09)	--	0.59	--	0.97	NA	NA	0.59	0.59
Benzo(b)fluoranthene	NA	2.93 (1.36)	--	5.9	--	9.7	NA	NA	5.9	5.9
Dibenz(a,h)anthracene	NA	0.77 (0.42)	--	0.59	--	0.97	NA	NA	0.59	0.59
Indeno(1,2,3-cd)pyrene	NA	1.61 (0.81)	--	5.9	--	9.7	NA	NA	5.9	5.9

[a] Shallow (0 to 1 ft below ground surface) surface soil and subsurface soil (1-7 ft BGS) are used for Resident Subsistence Farmer. EPCs are presented for surface soil (0-1 ft BGS). EPCs for subsurface soil are in (parentheses).
[b]Values from the Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4 (Shaw 2004).
[c]Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
[d]Value is for Aroclor-1254.
-- = 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. Not a COC at this aggregate or background criteria only apply to inorganics.

Table 3-5. Sediment Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at Load Line 12

COC	EPC (mg/kg)					Risk-Based Cleanup Goal[a] (mg/kg)				Background[b] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
						Adult		Child			
	AAC	MD	NAA	UL	WD	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics											
Arsenic	--	410	--	--	17	130	6.7	22	5.7	20	20
Silver	400	--	--	--	--	2,300[c]	--	370[c]	--	0	370[c]
Polychlorinated Biphenyls											
Aroclor-1016	--	2.8	--	--	--	3.5[d]	2.0[d]	1.2[d]	3.5[d]	NA	1.2[d]
Aroclor-1254	--	11	--	--	--	3.5	2.0	1.2	3.5	NA	1.2

Table 3-5. Sediment Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at Load Line 12 (continued)

COC	EPC (mg/kg)					Risk-Based Cleanup Goal[a] (mg/kg)				Background[b] (mg/kg)	Preliminary Cleanup Goal (mg/kg)
						Adult		Child			
	AAC	MD	NAA	UL	WD	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Semivolatiles											
Benz(a)anthracene	NA	NA	NA	4.9	NA	--	5.9	--	9.7	NA	5.9
Benzo(a)pyrene	0.097	0.14	0.18	4.4	0.1	--	0.59	--	0.97	NA	0.59
Benzo(b)fluoranthene	NA	NA	NA	6.4	NA	--	5.9	--	9.7	NA	5.9
Dibenz(a,h)anthracene	NA	NA	NA	0.67	NA	--	0.59	--	0.97	NA	0.59
Indeno(1,2,3-cd)pyrene	NA	NA	NA	3.9	NA	--	5.9	--	9.7	NA	5.9

[a] Values from the Proposed Remedial Goal Options for Soil at Load Lines 1, 2, 3, and 4 (Shaw 2004).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
[c]Value from Load Line 12 Phase II RI Report.
[d]Value is for Aroclor-1254.
AAC = Active Area Channel exposure unit.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
MD = Main Ditch exposure unit.
NAA = North of Active Area Channel exposure unit.
NA = Not applicable. Not a COC at this aggregate or background criteria only apply to inorganics.
UL = Upgradient Location exposure unit.
WD = West Ditches exposure unit.

Estimated sediment EPCs for arsenic at the West Ditches, benz(a)anthracene and indeno(1,2,3-cd)pyrene at the Upgradient Location, and benzo(a)pyrene at all sediment EUs except the Upgradient Location are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario. Estimated subsurface soil (1-7 ft BGS) EPCs for arsenic, benz(a)anthracene, benzo(b)fluoranthene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene are less than the preliminary cleanup goals for these 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 are presented for the National Guard Trainee in Table 3-6.

The COCs listed in Table 3-6 were identified in the HHRA (USACE 2004a) conducted prior to publication of the FWHHRAM (USACE 2004b). As time progressed, OHARNG training regimens were refined and exposure assumptions for the National Guard Trainees were adjusted to better reflect the activities. The exposure parameters used for the National Guard Trainee exposure to surface water (i.e., trainee ingests 11.2 L of surface water/year) in the HHRA are larger than the exposure parameters for a National Guard Trainee as recommended in the FWHHRAM (i.e., 3.9 L/year). As noted previously, exposure parameters recommended in the FWHHRAM were developed following land use recommendations for RVAAP in conjunction with OHARNG, Ohio EPA, and USACE to reflect estimates of exposure that are reasonable and protective for receptors at RVAAP based on most recent Ohio EPA and USEPA guidance. Therefore, the HHRA potentially provides a longer list of COCs and risk-based cleanup goals that is smaller than those that would be estimated using the FWHHRAM for this receptor.

Table 3-6. Surface Water Preliminary Cleanup Goals for National Guard Trainee Scenario at Load Line 12

COC	EPC (mg/L) NAA	Risk-Based Cleanup Goal[a] (mg/L) HI = 1.0	ILCR = 1E-05	Background[b] (mg/L)	Preliminary Cleanup Goal (mg/L)
Inorganics					
Arsenic	5.2	0.56	0.035	3.2	3.2
Semivolatiles					
bis(2-Ethylhexyl)phthalate	7.5	0.20	0.020	NA	0.020

[a] Values from the *Phase II Remedial Investigation Report for Load Line 12 (RVAAP-12)* (USACE 2004a).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NAA = North of Active Area exposure unit.
NA = Not applicable. Background criteria only apply to inorganics.

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 3-7.

The COCs listed in Table 3-7 were identified in the HHRA (USACE 2004a) conducted prior to publication of the FWHHRAM (USACE 2004b). As time progressed, exposure assumptions for the receptors were adjusted to better reflect the activities of those receptors. The exposure parameters used for the Resident Subsistence Farmer exposure to surface water (i.e., receptor uses surface water as drinking water source; adult ingests 2 L/day, child ingests 1.5 L/day) in the HHRA are larger than the exposure parameters for a Resident Subsistence Farmer as recommended in the FWHHRAM (i.e., receptor uses surface water for recreation; adult and child ingest 0.1 L/day). As noted previously, exposure parameters recommended in the FWHHRAM were developed following land use recommendations for RVAAP in conjunction with OHARNG, Ohio EPA, and USACE to reflect estimates of exposure that are reasonable and protective for receptors at RVAAP. Therefore, the HHRA provides a longer list of COCs and risk-based cleanup goals that is smaller than those that would be estimated using the FWHHRAM for this receptor.

Table 3-7. Surface Water Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at Load Line 12

COC	EPC (mg/L)				Risk-Based Cleanup Goal[a] (mg/L)				Backgrd[b] (mg/L)	Preliminary Cleanup Goal (mg/L)
					Adult		Child			
	AAC	MD	NAA	WD	HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics										
Arsenic	NA	NA	5.2	NA	0.011	0.000056	0.0031	0.00081	3.2	3.2
Manganese	3,600	3,100	NA	2,800	1.6	--	0.46	--	391	391
Nitrate	21,100	NA	NA	NA	58	--	17	--	0	17
Silver	92	NA	NA	NA	0.18	--	0.051	--	0	0.051
Explosives										
2,4,6-Trinitrotoluene	11	NA	NA	NA	0.018	0.028	0.0052	0.040	NA	0.028
2,4-Dinitrotoluene	1.6	0.24	0.14	NA	0.072	0.0012	0.021	0.0018	NA	0.0012
2,6-Dinitrotoluene	0.54	NA	NA	NA	0.036	0.0012	0.010	0.0018	NA	0.0012
RDX	6.6	NA	NA	NA	0.11	0.0077	0.031	0.011	NA	0.0077
Semivolatiles										
bis(2-Ethylhexyl)phthalate	NA	NA	7.5	NA	0.13	0.011	0.054	0.023	NA	0.011

[a] Values from the *Phase II Remedial Investigation Report for Load Line 12 (RVAAP-12)* (USACE 2004a).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
[c]Value from Load Line 12 Phase II RI Report.
[d]Value is for Aroclor-1254.
AAC = Active Area Channel exposure unit.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
MD = Main Ditch exposure unit.
NAA = North of Active Area Channel exposure unit.
NA = Not applicable. Not a COC at this aggregate or background criteria only apply to inorganics.
UL = Upgradient Location exposure unit.
WD = West Ditches exposure unit.

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 are presented for the National Guard Trainee in Table 3-8.

The estimated EPCs for 2-nitrotoluene and bis(2-ethylhexyl)phthalate are less than the preliminary cleanup goals established for these chemicals for the National Guard Trainee.

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 3-9.

Estimated groundwater EPCs for 2,4-DNT; RDX; and bis(2-ethylhexyl)phthalate are less than the preliminary cleanup goals for these COCs for the Resident Subsistence Farmer Scenario.

Table 3-8. Groundwater Preliminary Cleanup Goals for National Guard Trainee Scenario at Load Line 12

COC	EPC (mg/L)	Risk-Based Cleanup Goal[a] (mg/L)		Background (mg/L)[b]	Preliminary Cleanup Goal (mg/L)
		HI = 1.0	ILCR = 1E-05		
Inorganics					
Arsenic	0.055	0.042	0.0026	0.012	0.012
Explosives					
2-Nitrotoluene	0.0039	1.3	0.016	NA	0.016
		HI = 1.0	**ILCR = 1E-05**		
Semivolatiles					
Aldrin	0.000031	0.0013	0.000072	NA	0.000072
bis(2-Ethylhexyl)phthalate	0.0065	0.27	0.027	NA	0.027

[a] Values from the *Phase II Remedial Investigation Report for Load Line 12 (RVAAP-12)* (USACE 2004a).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
COC = Constituent of concern.
EPC = Exposure point concentration.
HI = Hazard index.
ILCR = Incremental lifetime cancer risk.
NA = Not applicable. Background criteria only apply to inorganics.

Table 3-9. Groundwater Preliminary Cleanup Goals for Resident Subsistence Farmer Scenario at Load Line 12

COC	EPC (mg/L)	Risk-Based Cleanup Goal[a] (mg/L)				Back-ground[b] (mg/L)	Preliminary Cleanup Goal (mg/L)
		Adult		Child			
		HI = 1.0	ILCR = 1E-05	HI = 1.0	ILCR = 1E-05		
Inorganics							
Arsenic	0.055	0.011	0.00056	0.0031	0.0081	0.012	0.012
Manganese	1.7	1.6	--	0.46	--	1.0	1.0
Nitrate	160	58	--	17	--	0	17
Thallium	0.0014	0.0029	--	0.00083	--	0	0.00083
Explosives							
2,4-Dinitrotoluene	0.00049	0.072	0.0012	0.021	0.0018	NA	0.0012
2-Nitrotoluene	0.0038	0.35	0.0036	0.10	0.0052	NA	0.0036
RDX	0.00097	0.11	0.0077	0.031	0.011	NA	0.0077
Semivolatiles							
Aldrin	0.000039	0.00051	0.000023	0.00019	0.000043	NA	0.000023
bis(2-Ethylhexyl)phthalate	0.0065	0.13	0.011	0.054	0.023	NA	0.011

[a] Values from the *Phase II Remedial Investigation Report for Load Line 12 (RVAAP-12)* (USACE 2004a).
[b] Final facility-wide background values for the Ravenna Army Ammunition Plant from the Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio (USACE 1999).
-- = Toxic endpoint not evaluated for this COC.
[c]Value from Load Line 12 Phase II RI Report.
[d]Value is for Aroclor-1254.
AAC = Active Area Channel exposure unit.
MD = Main Ditch exposure unit.
NAA = North of Active Area Channel exposure unit.
NA = Not applicable. Background criteria only apply to inorganics.
UL = Upgradient Location exposure unit.
WD = West Ditches exposure unit.

3.3.5 Risk Management Considerations

3.3.5.1 Soil and Sediment

For the National Guard Trainee, arsenic in sediment is recommended as a COC. No other soil or sediment COCs are recommended for evaluation of remedial alternatives for this receptor for the following reasons:

- The EPCs for aluminum and benzo(a)pyrene in deep surface soil (0-4 ft BGS) are less than the preliminary cleanup goals for these chemicals for the National Guard Trainee (Table 3-10). Furthermore, the eight individual detected concentrations (out of 163 total sample results) that are above the preliminary cleanup goal for aluminum are scattered throughout the deep surface soil in the Western Aggregate. Only one detected concentration (out of 57 total sample results) is above the preliminary cleanup goal for benzo(a)pyrene. It is unlikely that a National Guard Trainee would be exposed to concentrations at this single location over the entire exposure period for this representative receptor (936 hrs per year for 25 years).

- The EPCs for arsenic and manganese in deep surface soil (0-4 ft BGS) are less than both background and the preliminary cleanup goals for these chemicals for the National Guard Trainee (Table 3-10). Furthermore, only one detected concentration (out of 163 total sample results) in the deep surface soil in the Western Aggregate is above the preliminary cleanup goal for arsenic. As noted above, it is unlikely that a National Guard Trainee would be exposed to concentrations at this single location over the entire exposure period for this representative receptor. Seven individual detected concentrations (out of 163 total sample results) in the deep surface soil in the Western Aggregate are above the preliminary cleanup goal for manganese; these seven results are scattered throughout the deep surface soil in the Western Aggregate.

- The EPCs and all detected concentrations of 2,4,6-TNT; Aroclor-1260; benzo(a)anthracene; benzo(b)fluoranthene; and dibenz(a,h)anthracene in deep surface soil (0-4 ft BGS) are less than the preliminary cleanup goals for these chemicals for the National Guard Trainee (Table 3-10).

- The EPCs and all detected concentrations of Aroclor-1254 and benzo(a)pyrene in sediment are less than the preliminary cleanup goals for these chemicals for the National Guard Trainee (Table 3-10).

For residential land use, three soil COCs [2,4,6-TNT; benzo(a)pyrene; and dibenzo(a,h)anthracene] are recommended as COCs for evaluation of remedial alternatives in the FS for shallow surface soil (0-1 ft BGS) and subsurface soil (1-7 ft BGS) [benzo(a)pyrene only] in the Western Soil Aggregate. As shown in Table 3-11, the EPCs for these three chemicals exceed the preliminary cleanup goals established for residential land use. No other soil COCs are recommended for evaluation of remedial alternatives for residential land use for the following reasons:

- The EPCs for arsenic and benzo(b)fluoranthene in shallow surface soil (0-1 ft BGS) in the Western Aggregate are less than the preliminary cleanup goals for these chemicals for the Resident Subsistence Farmer (Table 3-11); the EPC for arsenic is also less than background. Furthermore, the 14 individual detected concentrations (out of 104 total sample results) that are above the preliminary cleanup goal for arsenic are located in areas proposed for soil removal scattered throughout the Western Aggregate and are surrounded by arsenic concentrations that are below the preliminary cleanup goal. Likewise, the two detected concentrations (out of 34 total sample results) that are above the preliminary cleanup goal for benzo(b)fluoranthene are not clustered together. Also, it is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period (e.g., 24 hrs per day for 350 days per year for 30 years for an Adult Resident Subsistence Farmer).

- The EPC for arsenic in subsurface surface soil (1-7 ft BGS) in the Western Aggregate is less than both its background and preliminary cleanup goal for the Resident Subsistence Farmer (Table 3-11). The three detected concentrations (out of 60 total sample results) in the subsurface surface soil in the Western Aggregate that are above the preliminary cleanup goal for arsenic are scattered throughout the aggregate and are surrounded by arsenic concentrations that are below the preliminary cleanup goal. Also, it is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period.

- The EPCs are less than the preliminary cleanup goals and only a single individual concentration exceeds the preliminary cleanup goals for the following COCs: Aroclor-1260, benz(*a*)anthracene, and indeno(1,2,3-*cd*)pyrene in shallow surface soil (0-1 ft BGS) in the Western Aggregate; benz(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene in subsurface soil (1-7 ft BGS) in the Western Aggregate; and arsenic in sediment in the West Ditches (Table 3-11). As noted above, it is unlikely that a resident would be exposed to concentrations at individual locations over the entire exposure period (e.g., 24 hrs/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

- The EPCs and all detected concentrations are less than the preliminary cleanup goals for the following COCs: benzo(a)pyrene in shallow surface soil (0-1 ft BGS) in the Eastern Aggregate; 2,6-DNT and RDX in shallow surface soil (0-1 ft BGS) in the Western Aggregate; indeno(1,2,3-cd)pyrene in subsurface soil (1-7 ft BGS) in the Western Aggregate; benzo(a)pyrene in sediment in the Active Area Channel, Main Ditch, North of Active Area, and West Ditches; and benz(a)anthracene and indeno(1,2,3-cd)pyrene in sediment in the Upgradient Location (Table 3-11).

Seven sediment COCs [arsenic, silver, Aroclor-1016, Aroclor-1254, benzo(a)pyrene, benzo(b)fluoranthene, and dibenz(a,h)anthracene] are recommended as COCs for evaluation of remedial alternatives for sediment. As shown in Table 3-11, the EPCs for these chemicals exceed the preliminary cleanup goals established for residential land use at one or more EUs. These chemicals are present in surrounding soil and no background values are available; therefore, an AOC-related source to the sediment is possible. Note, Aroclor-1016 has not been detected in surrounding soil; however, other

Aroclors have been detected indicating potential PCB contamination in this area. Arsenic generally was not detected above background in surrounding soils; however, the MDC in sediment was significantly higher than sediment background.

Other sediment COCs identified in the HHRA are not recommended for evaluation of remedial alternatives for residential land use for the following reasons:

- The EPCs and all detected concentrations of benzo(a)pyrene in sediment in the Active Area Channel, Main Ditch, North of Active Area, and in the West Ditches are less than the preliminary cleanup goals established for this chemical for the Resident Subsistence Farmer (Table 3-11).

- The EPCs and all detected concentrations of benz(a)anthracene and indeno(1,2,3-cd)pyrene in sediment in the Upgradient Location are less than the preliminary cleanup goals established for these chemicals for the Resident Subsistence Farmer (Table 3-11).

- The EPC for arsenic in sediment in the West Ditches is less than the preliminary cleanup goal. Only one individual detected concentration (out of eight total sample results) is barely above the preliminary cleanup goal and background. All surrounding arsenic concentrations are below 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 hrs/day for 350 days/year for 30 years for an Adult Resident Subsistence Farmer).

3.3.5.2 Surface Water

No surface water COCs are recommended for evaluation of remedial alternatives for the representative receptor (National Guard Trainee). As shown in Table 3-12, the EPCs for arsenic and bis(2-ethylhexyl)phthalate in surface water north of the Active Area are less than both background and preliminary cleanup goals established for this receptor.

For residential land use, two surface water COCs (nitrate and silver) are recommended as COCs for evaluation of remedial alternatives in the FS for surface water. As shown in Table 3-13, the EPCs for these chemicals exceed the preliminary cleanup goals established for residential land use at the Active Area Channel EU. These chemicals are present in surrounding soil and no background values are available; therefore, an AOC-related source to surface water is possible.

Other surface water COCs identified in the HHRA are not recommended for evaluation of remedial alternatives for residential land use because the EPCs for arsenic; manganese; 2,4,6-TNT; 2,4-DNT; 2,6-DNT; RDX; and bis(2-ethylhexyl)phthalate are below the preliminary cleanup goals established for these chemicals.

3.3.5.3 Groundwater

For the representative receptor (National Guard Trainee), no groundwater COCs are recommended for evaluation of remedial alternatives for the following reasons.

- The EPC for arsenic in groundwater exceeds background and the preliminary cleanup goal; however, arsenic is not elevated above background in overlying soil indicating no AOC-related source to the groundwater.

- The EPCs and all detected concentrations of 2-nitrotoluene and aldrin in groundwater are less than the preliminary cleanup goals for these chemicals for the National Guard Trainee (Table 3-12).

- The EPC for bis(2-ethylhexyl)phthalate in groundwater is less than the preliminary cleanup goal for the National Guard Trainee (Table 3-12).

For residential land use, one groundwater COC (nitrate) is recommended as a COC for evaluation of remedial alternatives in the FS for groundwater. As shown in Table 3-13, the EPC for nitrate exceeds the preliminary cleanup goal established for Resident Subsistence Farmer land use. Nitrate has been detected in subsurface soil (1-7 ft BGS) and no background values are available; therefore, an AOC related source to groundwater is possible.

Other groundwater COCs identified in the HHRA are not recommended for evaluation of remedial alternatives for residential land use for the following reasons:

- The EPCs for arsenic and aldrin in groundwater exceed the preliminary cleanup goals established for these chemicals; however, arsenic is not elevated above background in overlying soil indicating no AOC-related source to the groundwater.

- The EPC for thallium in groundwater exceeds the preliminary cleanup goals; however, thallium is not elevated above background in overlying soil indicating no AOC-related source to the groundwater. Note, thallium was detected in both surface (0-1 ft BGS) and subsurface (1-3 ft BGS) soil below the background concentration in subsurface soil, no surface soil background value is available.

- The EPCs for manganese, 2-nitrotoluene, and bis(2-ethylhexyl)phthalate in groundwater are less than the preliminary cleanup goals established for these chemicals for the Resident Subsistence Farmer (Table 3-13).

- The EPCs and all detected concentrations of 2,4-DNT and RDX in groundwater are less than the preliminary cleanup goals established for the Resident Subsistence Farmer (Table 3-13).

Table 3-10. Soil and Sediment COCs for Evaluation of Remedial Alternatives for National Guard Trainee Land Use at Load Line 12

COC[a]	Freq. of Detect	Measured Concentration (mg/kg)			Bkgd (mg/kg)	Detects > Bkg[e]	Preliminary Cleanup Goal[f] (mg/kg)	Detects > Preliminary Cleanup Goal[e]	Risk Management Considerations	Rec[g]
		Avg.	Max[b]	EPC[c]						
Deep Surface Soil(0-4 ft BGS): Western Aggregate										
Aluminum	163/163	17,610	197,000	20,590	17,700	32	34,942	8	EPC less than preliminary cleanup goal	NC
Arsenic	163/163	12	52	13	15	23	31	1	EPC less than background and preliminary cleanup goal	NC
Manganese	163/163	599	5,030	679	1,450	12	1,800	7	EPC less than background and preliminary cleanup goal	NC
2,4,6-Trinitrotoluene	18/38	43	1,400	105	NA	NA	1,600	0	All detects less than preliminary cleanup goal	NC
Aroclor-1260	10/42	0.26	8.2	0.59	NA	NA	35	0	All detects less than preliminary cleanup goal	NC
Benz(a)anthracene	34/57	1.2	28	2.0	NA	NA	100	0	All detects less than preliminary cleanup goal	NC
Benzo(a)pyrene	35/57	1.0	24	1.8	NA	NA	10	1	EPC less than preliminary cleanup goal	NC
Benzo(b)fluoranthene	38/57	1.2	27	2.1	NA	NA	100	0	All detects less than preliminary cleanup goal	NC
Dibenz(a,h)anthracene	12/57	0.41	3.2	0.59	NA	NA	10	0	All detects less than preliminary cleanup goal	NC
Sediment: Main Ditch										
Arsenic	4/ 4	223	418	408	20	4	31	4		FSCOC
Aroclor-1254	3/ 4	2.8	11	11	NA	NA	35	0	All detects less than preliminary cleanup goal	NC
Benzo(a)pyrene	3/ 4	0.18	0.14	0.14	NA	NA	10	0	All detects less than preliminary cleanup goal	NC
Sediment: Upgradient Location										
Benzo(a)pyrene	1/ 1	4.4	4.4	4.4	NA	NA	10	0	All detects less than preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the HHRA.

[b]Maximum detected concentration.

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

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

[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. (Figure 2-4 displays all of these soil locations and Figure 2-5 displays all of these sediment locations).

For deep surface soil in the Western Aggregate, eight locations had chemicals detected at concentrations above their respective aluminum preliminary cleanup goals: L12-070 from 0-1 ft (197,000 mg/kg); L12-077 from 0-1 ft (146,000 mg/kg); L12-069 from 0-1 ft (120,000 mg/kg); L12-061 from 0-1 ft (112,000 mg/kg); L12-081 from 0-1 ft (78,400 mg/kg); L12-073 from 0-1 ft (71,000 mg/kg); L12-075 from 0-1 ft (55,100 mg/kg); and L12-082 from 0-1 ft (39,200 mg/kg).

One deep surface soils sample in the Western Aggregate (L-080) had arsenic detected (51.7 mg/kg) above its preliminary cleanup goal of 31 mg/kg.

For deep surface soil in the Western Aggregate, seven locations had chemicals detected at concentrations above their respective manganese preliminary cleanup goals: L12-071 from 0-1 ft (5,030 mg/kg); L12-090 from 0-1 ft (3,090 mg/kg); L12-150 from 0-1 ft (2,820 mg/kg); L12-062 from 0-1 ft (2,190 mg/kg); L12-160 from 0-1 ft (1,970 mg/kg); L12-234 from 0-1 ft (1,970 mg/kg); and L12-063 from 0-1 ft (1,890 mg/kg).

One deep surface soils sample in the Western Aggregate (L-064) had benzo(a)pyrene detected (24 mg/kg) above its preliminary cleanup goal of 10 mg/kg.

For sediment in the Main Ditch, the following locations had arsenic detected at concentrations above its preliminary cleanup goal of 31 mg/kg: L12-208 (217 mg/kg); L12-209 (223 mg/kg); L12-226 (33.1 mg/kg); and L12-241 (418 mg/kg).

Table 3-10. Soil and Sediment COCs for Evaluation of Remedial Alternatives for National Guard Trainee Land Use at Load Line 12 (continued)

[f]Preliminary cleanup goal from Tables 3-2 and 3-3.
[g]Recommendation for COCs for evaluation of remedial alternatives.
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 3-11. Soil and Sediment COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at Load Line 12

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]
Shallow Surface Soil (0-1 ft BGS): Eastern Aggregate										
Benzo(a)pyrene	1/ 3	0.16	0.049	0.049	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC
Shallow Surface Soil (0-1 ft BGS): Western Aggregate										
Arsenic	104/104	12	52	13	15.4	14	15	14	EPC less than background and preliminary cleanup goal	NC
2,4,6-Trinitrotoluene	12/24	65	1,400	165	NA	NA	32	3		FSCOC
2,6-Dinitrotoluene	2/24	1.8	1.7	1.7	NA	NA	7.6	0	All detects less than preliminary cleanup goal	NC
RDX	1/24	3.9	12	9.3	NA	NA	47	0	All detects less than preliminary cleanup goal	NC
Aroclor-1260	6/22	0.45	8.2	1.1	NA	NA	1.2	1	EPC less than preliminary cleanup goal	NC
Benz(a)anthracene	21/34	1.5	28	2.9	NA	NA	5.9	1	EPC less than preliminary cleanup goal	NC
Benzo(a)pyrene	22/34	1.3	24	2.5	NA	NA	0.59	6		FSCOC
Benzo(b)fluoranthene	25/34	1.6	27	2.9	NA	NA	5.9	2	EPC less than preliminary cleanup goal	NC
Dibenz(a,h)anthracene	8/34	0.47	3.2	0.77	NA	NA	0.59	3		FSCOC
Indeno(1,2,3-cd)pyrene	14/34	0.91	13	1.6	NA	NA	5.9	1	EPC less than preliminary cleanup goal	NC
Subsurface Soil (1-7 ft BGS): Western Aggregate										
Arsenic	60/60	12	28	13	20	3	20	3	EPC less than background and preliminary cleanup goal	NC
Benz(a)anthracene	13/23	0.69	6.5	1.2	NA	NA	5.9	1	EPC less than preliminary cleanup goal	NC
Benzo(a)pyrene	13/23	0.63	5.8	1.1	NA	NA	0.59	3		FSCOC
Benzo(b)fluoranthene	13/23	0.77	7.3	1.4	NA	NA	5.9	1	EPC less than preliminary cleanup goal	NC
Dibenz(a,h)anthracene	4/23	0.33	0.94	0.42	NA	NA	0.59	1	EPC less than preliminary cleanup goal	NC
Indeno(1,2,3-cd)pyrene	7/23	0.53	3.7	0.81	NA	NA	5.9	0	All detects less than preliminary cleanup goal	NC
Sediment: Active Area Channel										
Silver	1/ 2	199	397	397	0	1	370	1	Detected in soil, no sediment background available	FSCOC
Benzo(a)pyrene	1/ 2	0.17	0.097	0.097	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC
Sediment: Main Ditch										
Arsenic	4/ 4	223	418	408	20	4	20	4		FSCOC
Aroclor-1016	1/ 4	0.85	3.3	2.8	NA	NA	1.2	1	Other Aroclors detected in soil	FSCOC
Aroclor-1254	3/ 4	2.822	11	11	NA	NA	1.2	1	Detected in soil	FSCOC
Benzo(a)pyrene	3/ 4	0.18	0.14	0.14	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC

Table 3-11. Soil and Sediment COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at Load Line 12 (continued)

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]
Sediment: North of Active Area										
Benzo(a)pyrene	1/ 6	0.25	0.18	0.18	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC
Sediment: Upgradient Location										
Benz(a)anthracene	1/ 1	4.9	4.9	4.9	NA	NA	5.9	0	All detects less than preliminary cleanup goal	NC
Benzo(a)pyrene	1/ 1	4.4	4.4	4.4	NA	NA	0.59	1	Detected in soil	FSCOC
Benzo(b)fluoranthene	1/ 1	6.4	6.4	6.4	NA	NA	5.9	1	Detected in soil	FSCOC
Dibenz(a,h)anthracene	1/ 1	0.67	0.67	0.67	NA	NA	0.59	1	Detected in soil	FSCOC
Indeno(1,2,3-cd)pyrene	1/ 1	3.9	3.9	3.9	NA	NA	5.9	0	All detects less than preliminary cleanup goal	NC
Sediment: West Ditches										
Arsenic	8/ 8	14	21	17	20	1	20	1	EPC less than preliminary cleanup goal/background	NC
Benzo(*a*)pyrene	2/ 8	0.36	0.10	0.10	NA	NA	0.59	0	All detects less than preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the HHRA.

[b]Maximum detected concentration.

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

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

[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal. (Figure 2-4 displays all of these soil locations and Figure 2-5 displays all of these sediment locations).

For shallow surface soil in the Western Aggregate, the following 14 locations had chemicals detected at concentrations above their respective arsenic preliminary cleanup goals: L12-080 (51.7 mg/kg), L12-110 (30.1 mg/kg), L12-155 (28.5 mg/kg), L12-071 (23.1 mg/kg), L12-068 (20.9 mg/kg), L12-102 (20.8 mg/kg), L12-106 (17.1 mg/kg), L12-157 (16.5 mg/kg),. L12-062 (16 mg/kg), L12-064 (16 mg/kg), L12-067 (15.7 mg/kg), L12-086 (15.7 mg/kg), L12-167 (15.7 mg/kg), L12-114 (15.5 mg/kg).

For shallow surface soil in the Western Aggregate, the following three locations had chemicals detected at concentrations above their respective 2,4,6-trinitrotoluene preliminary cleanup goals: L12-232 (1,400 mg/kg), L12-143 (81 mg/kg), and L12-147 (68 mg/kg).

One shallow surface soil sample in the Western Aggregate (L12-064) had Aroclor-1260 detected (8.2 mg/kg) above its preliminary cleanup goal of 1.2 mg/kg.

One shallow surface soil sample in the Western Aggregate (L12-064) had benz(a)anthracene detected (28 mg/kg) above its preliminary cleanup goal of 5.9 mg/kg.

For shallow surface soil in the Western Aggregate, the following six locations had chemicals detected at concentrations above the benzo(a)pyrene preliminary cleanup goal: L12-064 (24 mg/kg), L12-060 (4.7 mg/kg), L12-059 (3.5 mg/kg), L12-235 (1.3 mg/kg), L12-099 (0.82 mg/kg), and L12-100 (0.65 mg/kg).

For shallow surface soil in the Western Aggregate, the following two locations had chemicals detected at concentrations above the benzo(b)fluoranthene preliminary cleanup goal: L12-064 (27 mg/kg), and L12-060 (6.2 mg/kg).

For shallow surface soil in the Western Aggregate, the following three locations had chemicals detected at concentrations above the dibenz(a,h)anthracene preliminary cleanup goal: L12-064 (3.2 mg/kg J), L12-059 (0.67 mg/kg J), and L12-060 (0.67 mg/kg J).

One shallow surface soil sample in the Western Aggregate (L12-064) had indeno(1,2,3-cd)pyrene detected (13 mg/kg) above its preliminary cleanup goal of 5.9 mg/kg.

Table 3-11. Soil and Sediment COCs for Evaluation of Remedial Alternatives for Resident Subsistence Farmer Land Use at Load Line 12 (continued)

For subsurface soil in the Western Aggregate, the following three locations had chemicals detected at concentrations above the arsenic preliminary cleanup goal: L12-086 from 1 to 3 ft (27.7 mg/kg), L12-149 from 3 to 5 ft (26.9 mg/kg), and L12-237 from 1 to 3 ft (21 mg/kg).

One shallow subsurface soil sample in the Western Aggregate (L12-059) had benz(a)anthracene detected (6.5 mg/kg) above its preliminary cleanup goal of 5.9 mg/kg.

For subsurface soil in the Western Aggregate, the following three locations had chemicals detected at concentrations above the benzo(a)pyrene preliminary cleanup goal: L12-059 from 3 to 3.5 ft (5.8 mg/kg), L12-059 from 1 to 3 ft (2.7 mg/kg), and L12-060 from 1 to 2.5 ft (2 mg/kg).

One shallow subsurface soil sample in the Western Aggregate (L12-059) had benzo(b)fluoranthene detected (7.3 mg/kg) above its preliminary cleanup goal of 5.9 mg/kg.

One shallow subsurface soil sample in the Western Aggregate (L12-059) had dibenz(a,h)anthracene detected (0.94 mg/kg J) above its preliminary cleanup goal of 0.59 mg/kg.

One shallow sediment sample in the Active Area Channel (L12-213) had silver detected (397 mg/kg) above its preliminary cleanup goal of 370 mg/kg.

For sediment in the Main Ditch, the following locations had arsenic detected at concentrations above its preliminary cleanup goal of 31 mg/kg: L12-208 (217 mg/kg); L12-209 (223 mg/kg); L12-226 (33.1 mg/kg); and L12-241 (418 mg/kg).

One sediment sample in the Main Ditch (L12-208) had Aroclor-1016 detected (3.3 mg/kg) above the preliminary cleanup goal of 1.2 mg/kg.

One sediment sample in the Main Ditch (L12-208) had Aroclor-1254 detected (11 mg/kg) above the preliminary cleanup goal of 1.2 mg/kg.

One sediment sample in the Upgradient Location (L12-228) had benzo(a)pyrene detected (4.4 mg/kg) above the preliminary cleanup goal of 0.59 mg/kg.

One sediment sample in the Upgradient Location (L12-228) had benzo(b)fluoranthene detected (6.4 mg/kg) above the preliminary cleanup goal of 5.9 mg/kg.

One sediment sample in the Upgradient Location (L12-228) had dibenz(a,h)anthracene detected (0.67 mg/kg) above the preliminary cleanup goal of 0.59 mg/kg.

One sediment sample in the West Ditches (L12-212) had arsenic detected (20.6 mg/kg) above the preliminary cleanup goal of 20 mg/kg.

[f]Preliminary cleanup goal from Tables 3-4 and 3-5.

[g]Recommendation for COCs for evaluation of remedial alternatives.

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 3-12. Surface Water and Groundwater COCs for Evaluation of Remedial Alternatives for National Guard Trainee Land Use at Load Line 12

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: North of Active Area										
Arsenic	1/ 6	0.0034	0.0079	0.0052	3.2	0	0.035	0	Below background and preliminary cleanup goal	NC
bis(2-Ethylhexyl)phthalate	2/ 6	0.0054	0.01	0.0075	NA	NA	0.020	0	Below background and preliminary cleanup goal	NC
Groundwater: All (2000 to 2005) Data										
Arsenic	30/ 37	0.019	0.07	0.038	0.012	18	0.012	18	No AOC-related source from soil	NC
2-Nitrotoluene	12/ 33	0.0013	0.0065	0.0019	NA	NA	0.016	0	All detects less than preliminary cleanup goal	NC
Aldrin	1/ 37	0.000037	0.000054	0.000041	NA	NA	0.000072	0	All detects less than preliminary cleanup goal	NC
bis(2-Ethylhexyl)phthalate	5/ 37	0.0073	0.059	0.0098	NA	NA	0.027	1	EPC less than preliminary cleanup goal	NC
Groundwater: Recent (2004/2005) Data										
Arsenic	20/ 23	0.020	0.061	0.026	0.012	13	0.012	13	No AOC-related source from soil	NC
2-Nitrotoluene	0/ 19	ND	ND	ND	NA	NA	0.016	0	Not detected	NC
Aldrin	0/ 23	ND	ND	ND	NA	NA	0.000072	0	Not detected	NC
bis(2-Ethylhexyl)phthalate	3/ 23	0.0084	0.059	0.012	NA	NA	0.027	1	EPC less than preliminary cleanup goal	NC

[a]Constituent of concern (COC) identified in the HHRA.
[b]Maximum detected concentration.
[c]Exposure point concentration (EPC) is 95% upper confidence limit (UCL_{95}) of the mean or maximum detected concentration depending on number of samples and data distribution.
[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999).
[e]Number of detected concentrations exceeding the background criterion or preliminary cleanup goal.
[f]Preliminary cleanup goal from Tables 3-6 and 3-8.
[g]Recommendation for COCs for evaluation of remedial alternatives.
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.
ND = Not detected in any sample.

Table 3-13. Surface Water and Groundwater COCs for Evaluation of Remedial Alternatives for Residential Land Use at Load Line 12

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: Active Area Channel										
Manganese	2/ 2	1.8	3.6	3.6	391	0	391	0	All detects less than background and preliminary cleanup goal	NC
Nitrate	1/ 2	11	21	21	0	1	1.7	1	Detected in soil, no background available	FSCOC
Silver	1/ 2	0.049	0.092	0.092	0	1	0.051	1	Detected in soil, no background available	FSCOC
2,4,6-Trinitrotoluene	2/ 2	0.0059	0.011	0.011	NA	NA	0.028	0	All detects less than preliminary cleanup goal	NC
2,4-Dinitrotoluene	1/ 2	0.00087	0.0016	0.0016	NA	NA	0.0012	0	All detects less than preliminary cleanup goal	NC
2,6-Dinitrotoluene	1/ 2	0.00034	0.00054	0.00054	NA	NA	0.0012	0	All detects less than preliminary cleanup goal	NC
RDX	2/ 2	0.0034	0.0066	0.0066	NA	NA	0.0077	0	All detects less than preliminary cleanup goal	NC
Surface Water: Main Ditch										
Manganese	2/ 2	1.8	3.1	3.1	391	0	391	0	All detects less than background and preliminary cleanup goal	NC
2,4-Dinitrotoluene	1/ 2	0.0.00015	0.00024	0.00024	NA	NA	0.0012	0	All detects less than preliminary cleanup goal	NC
Surface Water: North of Active Area										
Arsenic	1/ 6	0.0034	0.0079	0.0052	3.2	0	3.2	0	All detects less than background and preliminary cleanup goal	NC
2,4-Dinitrotoluene	1/ 6	0.000091	0.0022	0.00014	NA	NA	0.0012	0	All detects less than preliminary cleanup goal	NC
bis(2-Ethylhexyl)phthalate	2/ 6	0.0054	0.010	0.0075	NA	NA	0.011	0	All detects less than preliminary cleanup goal	NC
Surface Water: West Ditches										
Manganese	3/ 3	2.2	2.8	2.8	391	0	391	0	All detects less than background and preliminary cleanup goal	NC
Groundwater: All (2000 to 2005) Data										
Arsenic	30/ 37	0.019	0.070	0.038	0.012	18	0.012	18	No AOC-related source from soil	NC
Manganese	35/ 37	0.47	1.8	0.90	1	6	1	6	EPC less than preliminary cleanup goal and background	NC
Nitrate	10/ 37	62	1200	125	0	10	17	4	Detected in soil, no background available	FSCOC
Thallium	2/ 37	0.0016	0.0029	0.0017	0	2	0.00083	2	No AOC-related source from soil	NC
2,4-Dinitrotoluene	6/ 37	0.00023	0.0012	0.00029	NA	NA	0.0012	0	All detects less than preliminary cleanup goal	NC

Table 3-13. Surface Water and Groundwater COCs for Evaluation of Remedial Alternatives for Residential Land Use at Load Line 12 (continued)

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]
2-Nitrotoluene	12/ 33	0.0013	0.0065	0.0019	NA	NA	0.0036	5	EPC less than preliminary cleanup goal	NC
RDX	8/ 37	0.00031	0.0020	0.00042	NA	NA	0.0077	0	All detects less than preliminary cleanup goal	NC
Aldrin	1/ 37	0.000037	0.000054	0.000041	NA	NA	0.000023	1	No AOC-related source from soil	NC
bis(2-Ethylhexyl)phthalate	5/ 37	0.0073	0.059	0.0098	NA	NA	0.011	2	EPC less than preliminary cleanup goal	NC
Groundwater: Recent (2004/2005) Data										
Arsenic	20/ 23	0.020	0.061	0.026	0.012	13	0.012	13	No AOC-related source from soil	NC
Manganese	21/ 23	0.40	1.8	1.0	1	3	1	3	EPC equal to preliminary cleanup goal	NC
Nitrate	7/ 23	59	1200	149	0	7	17	2	Detected in soil, no background available	FSCOC
Thallium	1/ 23	0.0018	0.0029	0.0020	0	1	0.00083	1	No AOC-related source from soil	NC
2,4-Dinitrotoluene	0/ 23	ND	ND	ND	NA	NA	0.0012	0	Not detected	NC
2-Nitrotoluene	0/ 19	ND	ND	ND	NA	NA	0.0036	0	Not detected	NC
RDX	1/ 23	0.00016	0.0015	0.00027	NA	NA	0.0077	0	All detects less than preliminary cleanup goal	NC
Aldrin	0/ 23	ND	ND	ND	NA	NA	0.000023	0	Not detected	NC
bis(2-Ethylhexyl)phthalate	3/ 23	0.0084	0.059	0.012	NA	NA	0.011	1	No AOC-related source from soil	NC

[a]Constituent of concern (COC) identified in the HHRA.
[b]Maximum detected concentration.
[c]Exposure point concentration (EPC) is 95% upper confidence limit (UCL_{95}) of the mean or maximum detected concentration depending on number of samples and data distribution.
[d] Final facility-wide background values for the Ravenna Army Ammunition Plant from the *Phase II Remedial Investigation Report for the Winklepeck Burning Grounds at the Ravenna Army Ammunition Plant, Ravenna, Ohio* (USACE 1999). 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 Tables 3-7 and 3-9.
[g]Recommendation for COCs for evaluation of remedial alternatives.
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.
ND = Not detected in any sample.

3.3.5.4 Summary of COCs for Evaluation of Remedial Alternatives

A summary of the preliminary cleanup goals for the COCs identified for evaluation of remedial alternatives is provided below and in Table 3-14 for the representative receptor (National Guard Trainee) and residential land use.

Table 3-14. Summary of COCs and Preliminary Cleanup Goals for Evaluation of Remedial Alternatives for Load Line 12

COC	Soil Preliminary Cleanup Goal (mg/kg)	Sediment Preliminary Cleanup Goal[a] (mg/kg)	Surface Water Preliminary Cleanup Goal (mg/L)	Groundwater Preliminary Cleanup Goal (mg/L)
Representative Land Use (Mounted Training, no digging – National Guard Trainee)				
Arsenic	--	31[f]	--	--
Residential Land Use (Resident Subsistence Farmer)				
Arsenic	--	20[f]	--	--
Nitrate	--	--	1.7[c]	17
Silver	--	370[d]	0.051[c]	--
2,4,6-Trinitrotoluene	32[b]	--	--	--
Benzo(a)pyrene	0.59[b,c]	0.59[e]	--	--
Benzo(b)fluoranthene	--	5.9[e]	--	--
Dibenz(a,h)anthracene	0.59[b]	0.59[e]	--	--
Aroclor-1016	--	1.2[f]	--	--
Aroclor-1254	--	1.2[f]	--	--

[a]Preliminary cleanup goals are the same for wet and dry sediments.
[b]COC for shallow surface soil (0-1 ft BGS) at the Western Soil Aggregate.
[c]COC for shallow surface soil (0-1 ft BGS) and subsurface soil (1-7 ft BGS) at the Western Soil Aggregate.
[d]COC at the Active Area Channel.
[e]COC at the Upgradient Location.
[f]COC at the Main Ditch.
-- = Chemical is not a COC for evaluation of remedial alternatives for this medium.
COC = Constituent of concern.

3.4 ECOLOGICAL PROTECTION

The ecological risk assessment (ERA) performed for Load Line 12 is available in the RI Report and summarized in Chapter 2 of this FS. Ohio EPA Levels I, II, and III were performed for Load Line 12 and show observed concentrations and TRVs where HQs exceed 1. The risk assessment in the RI Report identifies a variety of ecological receptor populations that could be at risk and identify the COPECs and COECs that could contribute to potential risks from exposure to contaminated media.

The risk assessment for Load Line 12 reported the ecological field work conducted at the AOC including an ecological reconnaissance that consisted of a walk-over by field biologists to look directly at the existing vegetation and animal life. This information is summarized in the RI Report.

These two pieces of information, risk assessment predictions (e.g., HQs) and field observations, were combined in a weight-of-evidence assessment. This combination of information shows that (1) while ESV exceedance and HQs being greater than 1 suggest risk to plants and selected animals at Load Line 12, (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 Load Line 12. The rationale for this is explained in detail and summarized below.

3.4.1 Ecological Preliminary Cleanup Goals for Load Line 12

It is recommended that no quantitative preliminary cleanup goals to protect ecological receptors be developed at Load Line 12. This recommendation comes from applying steps in the Facility-wide Ecological Risk Work Plan and specifically stops in Figure III to reach a Scientific Decision Management Point that few ecological resources are at risk. This recommendation is based principally on the following weight-of-evidence conclusions:

- Field observations (Level I of the Ohio EPA protocol) indicate there were few adverse ecological effects before the land was cleared (USACE 2004a), and there is ample nearby habitat to restore ecological communities at Load Line 12 and maintain them elsewhere on RVAAP. These observations imply that remediation to protect ecological resources is not necessary.

- A few adverse ecological effects from military training activities (e.g., mounted training and no digging) may occur, for example, tank trails, and brush hogging in an already heavily altered and disturbed habitat may occur in the future. Any remediation of habitat would tend to be re-disturbed by repeated military training activities and, thus, reduce the benefits of any remediation.

- Soil HQs are generally not highly elevated (see Table 2-3) and metal concentrations are similar to background (see Table 3-15) for many COECs.

- Potential remediation to meet human health preliminary cleanup goals would reduce overall contaminant concentrations.

- Additional removal of sediment or soil to further reduce any adverse ecological effects would destroy habitat without substantial benefit to the ecological resources at Load Line 12.

Stewardship of the environment will be a major consideration in all phases of planning, design, and implementation of the military mission (National Guard training). Presently, ecological risk is probable albeit the HQs are mostly less than 1 and, if not, mostly less than 100 for exposure scenarios considered to be protective of the ecological receptors at Load Line 12 (lead is around 400 and iron and aluminum are excluded). However, ecological reconnaissance near Load Line 12 corroborates the generally low HQs (i.e., low ecological risk). Potential removal of soil or sediment to achieve human health preliminary cleanup goals would reduce the overall concentrations of some contaminants and would have the effect of lowering the already low ecological exposure and risk. Some habitat alteration by mounted training and no digging exercises is expected to occur and result in some vegetation cut-back and/or removal by the action of brush-hogging (simpler or different habitat patches), shorted food chains in those patches (simpler habitat), and lower exposure (fewer organisms). However, these few changes would be small compared to the existing habitat disturbance (deforested areas, cut-over areas, and roads). These predictions and observations, along with the low concentrations of various COECs, make a case for no remediation recommended for ecological resources at Load Line 12.

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 preliminary cleanup goals or COEC concentrations used to define areas where remediation is needed to achieve protectiveness for ecological resources. A decision whether it is necessary to remediate because of potential harm to ecological receptors and whether it is necessary to set preliminary cleanup goals for ecological resources at Load Line 12 is not included in the RI Report. The following weight-of-evidence discussions provide input for that decision. A Level II SERA and a Level III were conducted at Load Line 12.

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

- AOC reconnaissance shows healthy terrestrial and aquatic ecosystems (Level I information in USACE 2004a) despite identification of COECs with HQs above 1 in the BERA.

- Land use at the AOC (military training) may impact ecological habitats, and military mission overrides the results of the HQ and field-truthing study.

- No unique ecological resources are found at Load Line 12, and nearby habitat offers home ranges for wildlife to escape from military land use activities.

- Soil HQs are generally not highly elevated and metal concentrations are similar to background for many COECs.

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

- Mitigations are of two types (chemical and physical) where removal of impacted soil or sediment (i.e., chemical) 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.

See Table 7-3 for more information about this dual protectiveness of human health and ecological resources. Each of these elements is explained below regarding the need for ecological preliminary cleanup goals 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 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 Load Line 12. These observations indicate that despite the presence of COPECs little adverse ecological effect has occurred at the AOC.

Vegetation and animals are found at Load Line 12, descriptions of which are detailed in the RI Report (USACE 2004a). Briefly, vegetation consists of many old-field communities with corridors and patches of forest vegetation. Animals consist of soil invertebrates and many species of insects, mammals, and birds. However, no known threatened and endangered species or unique natural resources are present at Load Line 12; substantiation of this is provided in Chapter 7 (ERA, natural resources chapter) of the RI Report for Load Line 12. Therefore, National Guard training activities may impact "normal" ecological resources.

3.4.2.2 Intensive and Potentially Extensive Habitat Alteration Anticipated

At Load Line 12, potential habitat disturbance because of National Guard mounted training activities may occur at any 1 acre (i.e., size of home range of small wildlife species). For example, tracked and wheeled operations may be conducted. Some small areas at Load Line 12 may be cleared of vegetation, but note that much stress to vegetation already exists at Load Line 12 (i.e., Load Line 12 is a previously disturbed area). Thus, any additional disturbance of vegetation would not necessarily add more stress. Additionally, environmental stewardship and sustainable resource practices are implemented to ensure that the lands and natural resources are maintained properly to be available for future training activities. Other places may have soil compaction and potentially disturbed vegetation, but there is already stress of that type too. Minor impacts on surface soil (0-1 ft BGS) may involve small petroleum, oil, and lubricant leaks and exhaust from vehicles. Tracked and wheeled operations could result in maneuver damage up to 4 ft BGS. Subsurface disturbance activities are not planned and digging and occupying fighting positions that extend below ground will be prohibited. Thus, any habitat disturbance at Load Line 12 would be limited.

The amount of minor future potential habitat disturbance is not known at this time; therefore, a scenario has been developed to predict what could happen. It is assumed that up to 50% (worst case scenario) of the area may be disturbed. Mostly, the vegetation may potentially be disturbed, while the soil would be disturbed to a lesser extent. Load Line 12 consists of about 80 acres of habitat. Thus, the potential disturbance area could be up to 40 acres. The potential acreage to be disturbed is small compared to the total facility acreage. For example, Load Line 12 is part of a facility that is about 22,000 acres; therefore, this area represents 40 acres out of 22,000 acres or about 0.2% of the total area. Potential disturbance to this small area would be insignificant to ecological function and sustainability.

Any potential habitat disturbance from military training may involve only a few acres within thousands of acres of adjacent habitats at RVAAP. For example, most of Load Line 12 (about 80 acres) consists of old field and cutover forest communities, including corridors and patches of trees (see Section 3.4.2.3 on nearby habitats). There are many hundreds of acres of these types of habitats at RVAAP. The other habitats at Load Line 12 are also part of the great diversity of habitat types near Load Line 12 and across thousands of acres at RVAAP.

In summary, impacts to habitat at Load Line 12 would be minimal due to an already disturbed habitat, the diversity of habitat in adjacent areas and elsewhere on the facility, and the continuation of environmental stewardship.

3.4.2.3 Nearby Habitats Offer Home Ranges to Wildlife

As stated above, ecological resources are "normal," and nearby habitat is available to receive wildlife that leaves the training area. Some vegetation, especially bushes and old-field vegetation, as well as some trees, is expected to be removed from within the load line. Old-field vegetation could be mowed or cleared in another way. Wildlife may be disturbed by the movement and noise of training equipment as well as trainees. Wildlife can leave and enter adjacent old fields and forest patches and vegetative corridors. As implied earlier, RVAAP has thousands of acres of habitat like that at the load line, and wildlife can find new home ranges there; therefore, any lack of protection as a result of not developing and implementing ecological preliminary cleanup goals would be minimal because sufficient reservoirs of habitat and wildlife exist.

3.4.2.4 Low Levels of Soil Contamination

Most of the soil HQs that exceed 1 are less than 10. At the Western Soil Aggregate, six metals have HQs greater than 10 (see Table 2-3); iron (2,640 for plants), aluminum (1,210 for shrews, 492 for plants, and 160 for mice), lead (434 for robins), chromium (103 for earthworms), zinc (29 for the robin) and vanadium (14 for plants). Four of these six metals (aluminum, chromium, iron, and vanadium) have EPCs that are less than 3 times background (Table 3-15) and two (cadmium and thallium) do not have background criteria available. The EPC for zinc is 4 times background and the EPC for lead is an order of magnitude greater than background. Furthermore, the HQs for iron and aluminum are likely overestimates due to low availability of the chemicals for biological uptake from soil (aluminum) or low confidence in the TRV (iron). At the Eastern Soil Aggregate, four metals have HQs greater than 10; however, the EPCs for all metals with HQs greater than 1 are less than background criteria.

Only two organic chemicals were identified as COECs: 2,4,6-TNT with HQs above 1 ranging from 2 to 31 (for shrew) and dieldrin with a maximum HQ of 1. 2,4,6-TNT was detected in 12 of 24 surface soil (0-1 ft BGS) samples in the Western Soil Aggregate. Dieldrin was detected in only 3 of 20 samples.

Table 3-15. Background Concentrations of Surface Soil (0-1 ft BGS) COECs at Load Line 12

COEC	Freq. of Detect	Average Result (mg/kg)	Maximum Detect (mg/kg)	EPC (mg/kg)	Bkg (mg/kg)	Number of Detects >Bkg
Eastern Soil Aggregate						
Aluminum	11/ 11	12,350	17,500	13,870	17,700	0
Antimony	1/ 11	0.6336	0.67	0.6486	0.96	0
Arsenic	11/ 11	8.855	12.3	9.989	15.4	0
Chromium	11/ 11	14.92	23.4	17.11	17.4	3
Copper	11/ 11	8.773	17.4	11.27	17.7	0
Iron	11/ 11	19,260	25,100	21,260	23,100	2
Lead	11/ 11	15.2	19.8	16.62	26.1	0
Manganese	11/ 11	240.6	862	384.4	1,450	0
Mercury	11/ 11	0.05227	0.12	0.06984	0.04	7
Nickel	11/ 11	11.97	22.1	14.63	21.1	1
Selenium	5/ 11	0.4891	0.82	0.6049	1.4	0
Thallium	11/ 11	0.5491	0.76	0.6106	0	11
Vanadium	11/ 11	22.31	32	24.95	31.1	1
Zinc	11/ 11	52.66	95.5	62.95	61.8	2
Western Soil Aggregate						
Aluminum	104/ 104	20,000	197,000	24,590	17,700	22
Antimony	58/ 103	3.208	79.4	5.022	0.96	28
Arsenic	104/ 104	11.85	51.7	12.81	15.4	14
Cadmium	63/ 104	0.8075	11.3	1.05	0	63
Chromium	104/ 104	33.02	327	41.36	17.4	51
Copper	104/ 104	406	7,770	608.3	17.7	75
Iron	104/ 104	23,950	155,000	26,430	23,100	46
Lead	104/ 104	167.5	7,680	292.1	26.1	60
Manganese	104/ 104	720.5	5,030	862.1	1,450	12
Mercury	97/ 101	0.2406	12.7	0.4491	0.04	65
Nickel	104/ 104	37.69	463	49.4	21.1	41
Selenium	45/ 104	0.6242	2.2	0.6985	1.4	8
Thallium	102/ 104	0.5255	1.2	0.5606	0	102
Vanadium	104/ 104	23.43	245	27.95	31.1	8
Zinc	103/ 103	212.6	1090	254.3	61.8	83

3.4.2.5 No to Low Contaminant Migration

The facility-wide surface water sampling and assessment 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 that report 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 Load Line 12, offsite migration is possible because ditches drained the central area and there are one or more ponds at the terminus of these ditches. Furthermore, there was exposure and ecological risk of various degrees in the aquatic ecosystems. This meant that offsite migration may have occurred, but is not necessarily continuing.

Onsite migration too is logically possible, but it is anticipated to be minimal for three reasons. First, AOC conditions – slope, soil type, and plant cover – are only slightly conducive to erosion. Second, there is no indication that organic compounds in soil are presently leaching to surface water and sediment in the pond, and this may apply to inorganics as well. Most importantly, AOC conditions are unlikely to change in a way that would lead to increases in surface water or sediment concentrations as a result of erosion or leaching from the soil. Future conditions are unlikely to pose an increase in exposure and risk to aquatic ecological receptors.

3.4.2.6 Mitigation Trade-off of Reducing Chemical Risk but Harming Environment

There is a trade-off of two kinds of risk: physical alterations and residual contamination. That is, 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 can be appropriate to allow plants and animals low in the food chain to be exposed to potentially 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 Load Line 12 activities, the military training mission requires activities that will alter some already greatly disturbed habitat and could create some sustained noise. Wildlife is expected to respond by moving away from the noise and likely returning to their cover and food when the noise abates.

There may be little benefit to removing contaminated soil or sediment because COEC concentrations are not necessarily harmful. For example, of the 15 metal COECs in soil in the Western Aggregate (Table 2-3), 4 have average concentrations less than background criteria, and another 4, including iron, aluminum, and chromium, have concentrations below twice background criteria. This small factor means that concentrations are not likely to be an exposure and risk issue.

3.4.2.7 Mitigation of Ecological Risk with Any Human Health-based Remediation

Potential remedial actions at Load Line 12 to reduce sediment concentrations of COCs below preliminary cleanup goals for human health (Section 3.3) could result in a decrease in ecological risk. If sediment is removed it would decrease the concentrations of COECs and reduce the number of COECs in sediment to which ecological receptors are exposed, thereby reducing ecological risk. Any sediment that is replaced because the concentration of human COCs were above preliminary cleanup goals would no longer have elevated concentrations of any COECs, thus reducing risk to ecological receptors from all COECs. Removal of impacted sediment triggered by human health preliminary cleanup goals would directly reduce the contaminant concentrations to which ecological receptors are exposed regardless of potential ecological preliminary cleanup goals. 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.

3.5 FATE AND TRANSPORT ASSESSMENT OF COCS IN SOILS

Impacted soils at Load Line 12 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 (National Guard Trainee 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 potentially impacting groundwater is detailed in Appendix 3A and summarized below:

- Assessment started with the soils CMCOPCs and CMCOCs identified in the fate and transport evaluation conducted in the RI for Load Line 12.
- 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 the potential for impacted soils to leach to groundwater.

3.5.1 Refined Soil Contributions to Groundwater Assessment

Based on the results of the Phase II RI for Load Line 12, constituents are evaluated for potential impacts in groundwater beneath the source and potential for impacts to groundwater at downgradient receptors. Further analysis of these constituents with regard to impacts to groundwater is summarized below.

Load Line 12 – Eastern Soil

- Chromium (total) and nickel are removed from further consideration of future groundwater impacts at Load Line 12 – Eastern Soil because all soil concentrations are below subsurface soil background.

Load Line 12 – Western Soil – Building 904

- Antimony, chromium (total), and manganese are removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Building 904 because all soil concentrations are below subsurface soil background.

- 1,3-DNB and 2,4-DNT are removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Building 904 because soil concentrations are all non-detects.

- 2,6-DNT: RI SESOIL source load modeling predicted maximum impact in 5 years. Given the AOC history, the maximum impact likely occurred in the past. 2,6-DNT is removed from further consideration of future groundwater impacts at Load Line 12 because there are few detections in soils; the predicted time of maximum impact to groundwater is 5 years (so maximum impact has likely passed); and 2,6-DNT has not been detected in surface water or groundwater.

- RDX: RI SESOIL source load modeling predicted maximum impact in 4 years. Given the AOC history, the maximum impact likely occurred in the past. RDX is removed from further consideration of future groundwater impacts at Load Line 12 because there are few detections in soils, the predicted time of maximum impact to groundwater is 4 years (so maximum impact has likely passed), and RDX has not been detected in the nearest monitoring wells (L12mw-153 and L12mw-154).

Load Line 12 – Western Soil – Building 905

- Barium is removed from further consideration of future groundwater impacts at Load Line 12 – Western Soils – Building 905 because the RI modeling included conservative assumptions (constant source, no degradation/attenuation of contamination), which overestimates groundwater impacts by a factor of 7; the maximum predicted impact is 2.48 mg/L compared to the MCL of 2.0 mg/L; and because no groundwater results currently exceed the MCL at Load Line 12.

- Chromium (total); 1,3-DNB; 2,4-DNT;, and RDX are removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Building 905 because all soil concentrations are below subsurface soil background.

Load Line 12 – Western Soil – Building FF19

- Antimony is detected in 38 of 54 soil samples and 30 of 38 detected results exceed background (1.0 mg/kg). The maximum surface/subsurface soil result is 79.4 mg/kg and occurs at station L12-081. Antimony was not detected in groundwater at nearby monitoring well L12mw-185. There were no detections in groundwater downgradient of Building FF19 through 2004. Antimony is retained for further consideration of future impacts to groundwater because antimony was widely detected in soils above background and was predicted to produce groundwater impacts beneath Load Line 12 – Western Soil – Building FF19 and at downgradient receptor locations.

- Chromium (total) is removed from further consideration of future groundwater impacts beneath Load Line 12 – Western Soil – Building FF19 because both observed concentrations in soils and the source concentration are significantly less than 76 times background. The modeling completed in the RI over-predicts chromium impacts to groundwater because conservative assumptions (constant source, no degradation/attenuation of contamination) were incorporated into the model. Background concentrations produce predicted results that exceed actual observed results by factors ranging from 76 to 393.

- Manganese 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 are less than subsurface soil background, and observed groundwater results are similar to background.

- Beta-BHC is removed from further consideration of future groundwater impacts because the single soil detection (LL12-059) at Building FF19 does not result in predicted impacts to groundwater beneath the AOC and beta-BHC is not detected in groundwater sampled at nearby monitoring well L12mw-185.

Load Line 12 – Western Soil – Team Track Area

- Antimony is detected in 8 of 8 soil samples. The maximum surface/subsurface soil result is 70.3 mg/kg at station L12-235. The soil EPC (5.0 mg/kg) also exceeds background (1.0 mg/kg). Antimony was not detected in groundwater at Load Line 12 through 2004. Antimony is retained for further consideration of future impacts to groundwater because antimony was widely detected in soils above background and was predicted to produce groundwater impacts beneath Load Line 12 – Western Soil – Team Track Area and at downgradient receptor locations.

- Chromium (total) is removed from further consideration of future groundwater impacts at Load Line 12 –Western Soil – Team Track Area because all soil concentrations are below subsurface soil background.

- Manganese and nickel are removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Team Track Area because all soil concentrations are below subsurface soil background.

- 3-Nitrotoluene: RI SESOIL source load modeling predicted maximum impact in 2 years. Given he AOC history, the maximum impact likely occurred in the past. 3-Nitrotoluene is removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Team Track area because soil detections are at low levels, the predicted time of maximum impact to groundwater is 2 years (so maximum impact has likely passed), and 3-nitrotoluene has only been detected in groundwater below the groundwater preliminary cleanup goals.

- 4-Nitrotoluene is removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil –Team Track Area because soil concentrations are all non-detects.

- Nitrobenzene: RI SESOIL source load modeling predicted maximum impact in 3 years. Given the AOC history, the maximum impact likely occurred in the past. Nitrobenzene is removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Team Track area because there is only a single detection; the predicted time of maximum impact to groundwater is 3 years (maximum impact has likely passed), and nitrobenzene has only been detected in groundwater below the groundwater preliminary cleanup goals.

3.5.2 Refined AOC-Specific Modeling Results

Based on analyses of the fate and transport assessment performed in support of the RI for Load Line 12, the following COCs were identified for further analysis using the SESOIL/AT123D models previously developed with refined input parameters:

- Antimony in soils at Load Line 12 – Western Soils – Building FF19, and
- Antimony in soils at Load Line 12 – Western Soils – Team Track Area.

Source areas, source area concentrations, and distances to potential receptors were updated for this refined analysis. Inherent limitations and assumptions of fate and transport modeling with SESOIL and AT123D are discussed in detail in Section 5.5.2.4 of the Phase II RI for Load Line 12.

At Load Line 12, focusing of the source areas in both functional areas produces increased concentrations in the representative soil profile. The source areas, average depths to the water table, and depths of soil detection for each revised scenario are presented in Table 3A-2 in Appendix 3A. Refinement of the source areas, however, requires recalibration of the recharge assigned in SESOIL; Table 3A-3 presents these updated parameters. The refined initial concentrations required for SESOIL modeling are presented in Table 3A-4 in Appendix 3A.

The results of refined fate and transport modeling are presented in Table 3-16. Antimony at Load Line 12 is predicted to exceed the MCL in groundwater beneath the refined Building FF19 source area and refined Team Track Area source area. Based on refined modeling with AT123D, antimony is not predicted to exceed the MCL at receptors downgradient of Building FF19 or the Team Track Area.

Table 3-16. Refined Fate and Transport Modeling Results

Scenario	SESOIL-Predicted $C_{leachate,max}$ at Source Water Table (mg/L)	Predicted T_{max} (years)	Predicted $C_{gw,max}$ at Source[a] (mg/L)	Predicted $C_{gw,max}$ at Receptor[a] (mg/L)	MCL (mg/L)	Exceedance at Exposure Point
Load Line 12 - Antimony FF19 - Refined Source	3.17E-01	807	2.04E-01	0	6.00E-03	No
Load Line 12 - Antimony Team Track Area Refined Source	8.29E-01	274	3.96E-01	4.76E-03	6.00E-03	No

[a]The predicted maximum concentration in groundwater Cgw,max is calculated using the AT123D model based on contaminant loading predicted by SESOIL.
MCL = Maximum contaminant level.

Groundwater impacts in excess of MCLs are predicted for impacted soils at Load Line 12 as noted below:

- Antimony in soils at Load Line 12 – Western Soils – Building FF19, and
- Antimony in soils at Load Line 12 – Western Soils – Team Track Area.

The predicted impacts in groundwater beneath Load Line 12 of these COCs are not predicted to reach downgradient receptor locations. However, soil remediation for protection of groundwater would be required for antimony in soils at Load Line 12 with respect to residential land use.

3.6 COCS FOR REMEDIAL ALTERNATIVE EVALUATION

The final list of COCs for evaluation of remedial alternatives were identified for Load Line 12 in the previous sections (Sections 3.3, 3.4, and 3.5) and 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.

One COC (arsenic) is recommended for evaluation of remedial alternatives for sediment at Load Line 12 for the representative receptor (National Guard Trainee). Inorganics, explosives, PAHs, and PCBs are recommended for evaluation of remedial alternatives for soil and sediment for residential land use at

Load Line 12 (Table 3-17). Inorganics also are recommended for evaluation of remedial options for surface water and groundwater.

COCs identified in soils/dry sediments will be carried forward for evaluation of remedial alternatives in Chapters 5, 6, and 7 of this FS Report. COCs identified in aqueous media (i.e., groundwater and surface water) will be carried forward for evaluation of remedial options in Chapter 5 of this FS Report.

Table 3-17. Summary of COCs for Evaluation of Remedial Alternatives at Load Line 12

Soil	Sediment	Surface Water	Groundwater
Representative Land Use (Mounted Training, no digging – National Guard Trainee)			
--	Arsenic	--	--
Residential Land Use (Resident Subsistence Farmer)			
Antimony[g]			
--	Arsenic	--	--
--	--	Nitrate[c]	Nitrate
--	Silver[c]	Silver[c]	--
2,4,6-Trinitrotoluene[a]	--	--	--
Benzo(a)pyrene[a,b]	Benzo(a)pyrene[d]	--	--
--	Benzo(b)fluoranthene[d]	--	--
Dibenz(a,h)anthracene[a]	Dibenz(a,h)anthracene[d]	--	--
--	Aroclor-1016[e]	--	--
--	Aroclor-1254[e]	--	--

[a]COC for shallow surface soil (0-1 ft BGS) at the Western Soil Aggregate and surface soil (0-3 ft BGS) at the Team Track Area.
[b]COC for shallow surface soil (0-1 ft BGS) and subsurface soil (1-7 ft BGS) at the Western Soil Aggregate.
[c]COC at the Active Area Channel.
[d]COC at the Upgradient Location.
[e]COC at the Main Ditch.
[f]COC at the Active Area Channel, Main Ditch, and North of Active Area Channel.
[g]COC in soil identified for evaluation of remedial alternatives to reduce future impacts to groundwater.
-- = No COCs identified for evaluation of remedial alternatives in the FS for this medium.
COC = Constituent of concern.

3.7 EXTENT AND VOLUME CALCULATIONS

Estimated volumes are generated of impacted soils and/or dry sediments at Load Line 12 where COCs in these media were identified (Section 3.6) to be evaluated further in the FS. Analytical data collected during the RIs 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 and dry sediment exceeding preliminary cleanup goals for National Guard Trainee and Resident Subsistence Farmer land use are summarized in Table 3-18. Supplemental information and data are presented in Appendix 3B.

Table 3-18. Estimated Volumes of Impacted Soils/Dry 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)
Load Line 12 National Guard Trainee Land Use – Sediment*	10,600	20,900	774	26,125	968	31,350	1,161
Load Line 12 Resident Subsistence Farmer Land Use – Sediment*	11,706	21,453	794	26,816	993	32,180	1,191
Load Line 12 Resident Subsistence Farmer Land Use – Soil	103,372	198,168	11,337	247,710	14,171	297,252	17,006

*volumes are calculated based on sediment removal varying from at 0.5 to 2.0 ft in depth

[a] Includes 25% constructability factor

[b] Includes 20% swell factor.

4.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Agencies responsible for remedial actions under CERCLA must ensure selected remedies meet ARARs. The following sections describe proposed ARARs for Load Line 12.

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 siting 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 Regulation (CFR)* § 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* § 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 Department 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, 7/30/1998, 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, 9/2/03, 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, NCP, and all other applicable federal and state laws and regulations."

4.2 POTENTIAL ARARS FOR LOAD LINE 12

EPA 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.

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 Chemical-Specific ARARs for Soils

A review of the requirements has shown that the only potential chemical-specific ARARs for Load Line 12 are the Toxic Substances Control Act (TSCA) requirements associated with PCBs in soil found at 40 *CFR* 761.61. PCBs have been detected in soils/sediments at Load Line 12. When PCBs are found at a CERCLA site at any concentration, they must be evaluated. One potential ARAR exists for PCBs in soil, 40 *CFR* Section 761.61, effective August 28, 1998, which provides for cleanup and disposal of PCB remediation wastes. PCB remediation wastes include the following:

- Wastes with PCB concentrations of ≥ 50 ppm if the PCBs were placed in the soil before April 18, 1978;

- Wastes with any PCB concentration if the materials are from a source not authorized for use under 40 *CFR* Part 761 (such as contaminated soil disposal); and

- Wastes with any PCB concentration if the materials are from a source of ≥ 500 ppm PCB beginning on April 18, 1978, or ≥ 50 ppm PCB beginning on July 2, 1979.

PCB remediation waste includes debris generated as a result of a PCB spill cleanup, as well as any other debris generated during a PCB spill cleanup, including soil and sediments, which wastes are comprised of settled sediment fines and aqueous decantate from sediment (40 *CFR* § 761.3). PCB cleanup standards for soils vary with the cleanup option chosen – self-implementing, performance-based, or risk-based. Self-implementing cleanups were not intended for CERCLA actions; rather, risk-based responses were thought to provide the flexibility necessary for a CERCLA cleanup (63 Fed. Reg. 35407, June 29, 1998; 59 Fed. Reg. 62796, Dec. 6, 1994). However, the self-implementing procedure may be used. It is supposed to be used at a moderately sized site where there will be minimal environmental impact from remedial activities. If used at a CERCLA site where it is later believed that PCBs are not sufficiently remediated or the land use changes, the site can be subject to further remediation [40 *CFR* § 761.61(a)(1) and (4)]. Cleanup standards specified in 40 *CFR* § 761.61(a)(4) are:

1. In high-occupancy areas, ≤ 1 ppm PCB for release of property without further conditions. If PCB concentrations of ≥1 ppm but ≤ 10 ppm remain, the area must be covered with a PCB cap. High-occupancy areas are those with exposure of more than 335 hrs/year (an average of 6.7 hrs or more per week): for example, a residence, school, sleeping quarters, or cafeteria in an industrial facility; and

2. In low-occupancy areas, the cleanup level is ≤ 25 ppm. Concentrations of ≥ 25 ppm but ≤ 50 ppm may remain onsite if the site is secured by a fence and marked with a sign including the large mark (ML) mark. Concentrations of ≥ 25 ppm but ≤ 100 ppm may remain onsite if the site is covered with a PCB cap. Low-occupancy areas are those with exposure of no more than 335 hrs/year (an average of 6.7 hrs/week).

PCBs were detected in soils at Load Line 12 at concentrations below 50 ppm. The specific source of PCBs in the soils is unknown; however, it is most likely they were placed in soil before 1978. If the PCB contamination is placed in soil before 1978, then it is not a "PCB remediation waste," as defined in 40 *CFR* § 761.3, because it does not contain PCBs at concentrations of ≥ 50 ppm. As provided under 40 *CFR* § 761.50(b)(3), this soil does not require remediation unless the Regional Administrator makes a determination that ongoing disposal in the form of leaching or other uncontrolled releases poses an unreasonable risk of injury to health or the environment, and requires cleanup in accordance with 40 *CFR* § 761.61. The self-implementing procedures and performance-based cleanup standards would not be relevant or appropriate and, therefore, not an ARAR. Further evaluation of PCB contamination and the need for potential cleanup was evaluated as part of the risk assessment for this FS. Because PCBs are present in soil and cleanup is being conducted under CERCLA, these requirements are relevant but not appropriate due to the low concentration of PCBs found. Although this requirement is not considered to be an ARAR, the CERCLA risk assessment conducted as part of the RI/FS satisfies the requirements of 40 *CFR* 761.61(c) for a risk-based approval.

4.2.2 Potential Action-Specific ARARs for Soils

If soil contamination at Load Line 12 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 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 considered chemical-specific ARARs, they are potential action-specific ARARs when the remedial action includes the generation and subsequent management of environmental media that is or contains a hazardous waste. Standards that directly address land disposal may be potential ARARs at Load Line 12. 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.

EPA 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.

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 redepositing the soil within the land unit for disposal, 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 Ohio Administrative Code (OAC) § 3745-700-44, LDR standards for contaminated debris at OAC § 3745-47, Universal Treatment Standards (UTS) at OAC § 3745-270-48, and Alternative Standards for Contaminated Soil at OAC § 3745-270-49.

Ohio has adopted the alternative soil treatment standards as promulgated by USEPA in its Phase IV LDR rule, effective August 1998. Basically, 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 § 3745-270-40 that 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 Load Line 12, then the design and treatment standards established at OAC §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 means 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.

Potential ARARs are summarized in Table 4-1.

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 § 3745-400-49 OAC § 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: 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 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 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 § 3745-400-49 OAC § 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 § 3745-400-47 Treatment residues continue to be subject to RCRA hazardous waste requirements
Soils/Debris Contaminated with RCRA Hazardous Waste – Variance OAC § 3745-400-44	The Director will recognize a variance approved by the EPA 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 Corrective Action Management Unit (CAMU) OAC § 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 30 cm 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

CAMU = Corrective action management unit.
LDR = Land disposal restrictions.
OAC = Ohio Administrative Code.
RCRA = Resource Conservation and Recovery Act.
UHC = Underlying hazardous constituent.
UTS = Universal Treatment Standard.

4.2.2.1 **Potential Location-Specific ARARs**

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 a 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 a 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, it bears repeating that 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.

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5.0 TECHNOLOGY TYPES AND PROCESS OPTIONS

This chapter describes the identification and screening of technology types and process options for COCs in impacted soils and dry sediment at Load Line 12 (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. These steps include:

- Identifying general classes of response actions, or general response actions (GRAs), suitable for Load Line 12 (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).

Remediation of impacts to groundwater, surface water, and wet sediment are not addressed in this FS; however, a preliminary evaluation of options to address impacts to groundwater and surface water is included in Appendix 5 to support future considerations regarding the need for remedial action either on an AOC-specific or a facility-wide basis.

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 Load Line 12. 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, sediment, surface water and groundwater). 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 Load Line 12 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* § 300.430(a)(1)(iii)(D)].

If land use controls are selected as a component of a remedial alternative achieving National Guard Trainee 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 Load Line 12 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 Load Line 12 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 transport could be used to ship waste materials onsite or offsite.

5.2 INITIAL SCREENING OF TECHNOLOGIES ~ SOILS/DRY SEDIMENTS

This section describes the identification and initial screening of potential technologies to achieve soil and dry sediment RAOs at Load Line 12. Technology types and process options for Load Line 12 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.

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 Load Line 12 include land use controls and 5-year reviews. 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 depends 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. AOCs containing residual contamination above acceptable concentrations for unrestricted (i.e., 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 at that time 5-year reviews may be discontinued.

Five-year reviews will include the review of sampling and monitoring plans and results from monitoring activities, conducting of interviews to provide additional information about the AOC's status, and AOC 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 unrestricted (i.e., 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 Load Line 12 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 AOC remediation and is applicable to all COCs at Load Line 12. 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 for soils is retained as an option to be further evaluated for Load Line 12.

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 Load Line 12.

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 (S/S).

Chemical Redox: 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. Most of Load Line 12 is underlain by relatively uniform silt to silty clay till. Bedrock beneath the AOC consists of shale. Phase II RI slug test data for unconsolidated zone wells show relatively low hydraulic conductivity values ranging from 23.5 x 10-6 to 2.64 x 10-4 cm/sec. Results from Shelby tube analyses ranged from 3.9 x 10-8 to 8.7 x 10-6 cm/sec. Based on these data, introduction and adequate dispersal of sufficient quantities of reagents within the unconsolidated zone is likely not feasible. For these reasons, chemical Redox is not retained for further evaluation for Load Line 12.

Electrokinetic separation: Electrokinetic separation is a method by which 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 at treating explosives.

Electrokinetic separation is retained as process options for Load Line 12.

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^{TM} 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 Load Line 12 involve surficial soils and sediment that render the installation of horizontal and vertical fractures impractical and undesirable respectively. Therefore, fracturing is not retained for Load Line 12.

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 Load Line 12 render implementation of in situ soil flushing problematic. Contaminated soils and sediment at Load Line 12 are surficial in nature and associated with drainage ditches and 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.

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 Load Line 12. In addition, the surficial nature of impacted soils and sediment is not conducive to SVE techniques.

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 1,600 to 2,000 °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. Because organic compounds are generally not immobilized, it is generally considered ineffective for treating explosives.

S/S is retained for contaminated soils at Load Line 12.

5.2.5.2 Ex Situ Physical/Chemical Treatment

Ex situ physical/chemical treatment options apply to contaminated soils that 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 because 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.

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 Load Line 12. 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 site.

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.

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.

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.

Monitored Natural Attenuation (MNA): 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.

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 are 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 Load Line 12. 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.

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 is not present at the 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 Load Line 12 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. These options are further evaluated (Section 5.3) to identify the best set of options from which to develop remedial alternatives for Load Line 12.

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

Process Option
No Action
Land Use Controls and 5-Year Reviews
Capping
Native Soil/Sediment
Clay
Synthetic Liner
Multi-Layered
Asphalt/Concrete
Bulk Removal
Excavation
In Situ Physical/Chemical
Electrokinetic Separation
Stabilization/Solidification
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 is presented below and summarized in Table 5-3 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 criteria (i.e., effectiveness, implementability, and cost) to determine the most appropriate technologies for remediating Load Line 12. The remedial options retained from the 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 additional protection for human health and the environment. Any current AOC 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 current use 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 site-related contaminants.

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. Five-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 Load Line 12. The US Army has managed this land in the past under internal policies and procedures and future use of Load Line 12 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. 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 monitoring are retained for inclusion in remedial alternatives for Load Line 12.

5.3.4 Containment

Containment technologies protect human health and the environment by physically separating the impacted materials from any potential receptors. Initial screening results indicated containment technologies were potentially applicable to Load Line 12. Detailed screening results are described below.

Effectiveness: An engineered cap is a proven effective technology that provides a physical barrier between receptors and contaminated soils. The cap would eliminate the potential for direct contact (absorption, ingestion, or inhalation), minimize water infiltration through contaminated media, and reduce the mobilization of contaminants. Regular maintenance of the cap would be required.

Implementability: Implementing containment technologies at Load Line 12 would be difficult. Load Line 12 impacted areas are limited in extent and widely dispersed across the AOC, including within drainage structures such as drainage ditches. Numerous capping systems would be required to be constructed with substantial clearing and grubbing, rerouting of utilities, and other preparation activities required. Contaminated soils may need to be amended (i.e., materials added to increase the strength of soils) to reduce future subsidence. The numerous resulting caps would require perpetual maintenance and create logistic issues for training exercises to be conducted in the area. Implementing containment technologies may also be difficult to implement administratively since the substantive requirements of a permit must be met per CERCLA. Local stakeholders including government officials may oppose onsite capping. Monitoring also would be required for as long as the media under the cap present a potential threat to human health or the environment. The long-term maintenance and monitoring requirements could be difficult to maintain due to the need to transfer information through generations.

Cost: The cost effectiveness of containment technologies at Load Line 12 is rated moderate to low. Capital costs including soil excavation, transportation, and installation of capping systems across the AOC would be high. O&M costs would be a function of the degree of activity needed to address soil subsidence and long-term monitoring requirements.

Containment technologies are not retained as a process option for Load Line 12.

5.3.5 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 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.

5.3.6 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.

5.3.6.1 In Situ Electrokinetic Separation

In situ electrokinetic separation was initially screened as potentially applicable to Load Line 12. Results of the detailed screening analysis are presented below.

Effectiveness: Electrokinetic separation is effective at further concentrating metals and polar organic compounds for more directed and lower-volume removal. It is most effective in low permeability clayey soils due to the tendency for clay particles to be charged.

Implementability: Implementing in situ electrokinetic separation at Load Line 12 would be difficult. Contaminated soils and sediment are located in drainage ditches and areas prone to flooding. Soils and sediment would require excavation and possibly further treatment after separation. The materials would be lower in volume than the original waste material. This process is best used in small areas with diffuse concentrations. The variable soils encountered at Load Line 12 may hinder implementation. Qualified vendors and equipment are readily available to perform this treatment operation.

Cost: The cost effectiveness of in situ electrokinetic separation technology is rated moderate to low. Capital costs would be high, although no O&M costs beyond the initial treatment are expected. Disposal costs would be decreased with this treatment alternative due to the decreased volume of waste requiring disposal, assuming that remaining contaminant concentrations do not require additional disposal requirements.

Electrokinetic separation is not retained for further evaluation for Load Line 12. Potential implementation difficulties due to AOC conditions combined with cost effectiveness considerations render this option undesirable.

5.3.6.2 In Situ Stabilization/Solidification

Initial screening results indicated in situ S/S was potentially applicable to Load Line 12. The detailed screening evaluation of this remedial technology is presented below.

Effectiveness: In situ S/S is effective in immobilizing inorganic contaminants. Treatment generally is of limited effectiveness for SVOCs and explosives. Heat from hydration or vitrification processes may release organic vapors and require air treatment. Chemical fixation may result in substantial increases in waste volumes requiring disposal.

Implementability: In situ S/S would be difficult to implement at Load Line 12. The AOC's numerous small contaminated areas dispersed across the AOC would require several mobilization/demobilization events. In situ treatment of contaminated sediments in the Load Line 12 drainage ditches would require special provisions. Considerable logistic difficulties may be encountered for training exercises conducted in treatment areas.

Cost: The cost effectiveness of in situ S/S technologies for Load Line 12 is low. The numerous mobilization events and start-up times required increase costs associated with this technology.

In situ S/S is not retained for Load Line 12 due to the limited effectiveness of the technology, difficulty of implementation, and low potential cost effectiveness.

5.3.6.3 Ex Situ Chemical Extraction and Soil Washing

Chemical extraction and soil washing are similar technologies that utilize a solvent to extract contaminants from soil/sediment media. Both technologies were initially screened to be applicable to Load Line 12. 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 high explosive constituents, is uncertain. Laboratory and conceptual design studies would need to be conducted on soils from Load Line 12 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 Load Line 12 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 Load Line 12 due to the questionable effectiveness of the technology, difficulty of implementation, and low potential cost effectiveness.

5.3.6.4 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 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 Load Line 12. 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 Load Line 12. 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 contaminant 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 Load Line 12 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 is retained for Load Line 12. Vitrification is not retained due to the uncertainties associated with confirmation sampling, high cost, and potential dangers to onsite workers during implementation.

5.3.7 Disposal and Handling

Initial screening results indicated three disposal options and one handling option are potentially applicable to Load Line 12. Detailed screening evaluations for these remedial technologies are presented below.

5.3.7.1 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 site 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 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 Load Line 12. The difficulty in implementing this option combined with low cost effectiveness render this option undesirable.

5.3.7.2 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 5.3.7.1.

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 Load Line 12. This option is difficult to implement and has a low cost effectiveness thereby making this option undesirable.

5.3.7.3 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 AOC remediation and separating impacted materials from potential receptors.

Implementability: Using an existing facility to dispose of waste would be easily implemented 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 Load Line 12.

5.3.8 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 site 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 Load Line 12.

5.4 RETAINED PROCESS OPTIONS FOR SOILS/DRY SEDIMENT

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 Load Line 12.

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

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)
Treatment	Ex Situ Physical/Chemical (Soil/Sediment)	Stabilization/Solidification (Chemical Fixation)
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 sediment at Load Line 12.

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

General Response Action	Technology Type	Process Options	Description	Screening Comments
No Action	None	None	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	
	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	Potentially applicable. Requires long-term maintenance. Limits future use
		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 for soils and dry sediment
Treatment	In Situ Physical/ Chemical (Soil/ Sediment)	Chemical Redox	Addition of chemicals to raise or lower oxidation state of contaminants, chemically converting hazardous materials to less hazardous or non-toxic	Not applicable. Not effective for Load Line 12 COCs
		Electrokinetic Separation	Low voltage current applied to media by ceramic electrodes. Positively and negatively charged metal and organic ions migrate to opposite electrodes	Potentially applicable for soils and non-wet sediment
		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 soils. 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. Load Line 12 AOC conditions (i.e., contaminated surficial soils) 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. Not effective for Load Line 12 COC. AOC conditions (i.e., contaminated surficial soils) 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	Potentially applicable
Treatment (continued)	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 Load Line 12 COCs
		Dehalogenation	Uses various methods to remove a halogen molecule from organics, reducing toxicity	Not applicable. Not effective for Load Line 12 COC
		Separation	Physically sort soils to remove contaminated from uncontaminated portions	Not applicable. Not effective for Load Line 12 COCs
		Soil Washing	Reduces contaminated media volume by dissolving or suspending contaminants, or physically separating uncontaminated portions from contaminated portions	Potentially applicable. Limited application experience in explosives remediation
		Stabilization/Solidification	See above (In Situ Stabilization/Solidification)	Potentially limited applicability. Not applicable to explosive contaminants in Load Line 12 sediment and soils. Does not reduce total metals concentration

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 Load Line 12 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 Load Line 12 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 Load Line 12 COC
		Thermal Desorption	Heat is applied to volatilize water and organics, which are carried to a gas treatment system	Not applicable. Not effective for Load Line 12 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

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	Implementability	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	Institutional 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
	Engineered Controls	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	Easy	Moderate to low cost effectiveness	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: Effectiveness	Detailed Screening Criteria: Implementability	Detailed Screening Criteria: Cost	Screening Results
Treatment	Ex Situ Physical/Chemical (Soil/Sediment)	Chemical Extraction	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. May result in net increases in waste volumes	Easy to moderate	Moderate cost effectiveness	Retained
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

6.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

This chapter describes the remedial alternatives assembled for impacted soils and/or dry sediments at Load Line 12. The remedial alternatives were constructed by combining GRAs, 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 and/or dry sediments at Load Line 12 (Section 3.6) and encompass a range of potential remedial actions:

- Alternative 1: No Action;
- Alternative 2: Limited Action;
- Alternative 3: Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use;
- Alternative 4: Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use;
- Alternative 5: Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use; and
- Alternative 6: Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use.

Alternative 1 is the no action response required under NCP. Alternative 2 relies on limited AOC improvements in conjunction with land use controls. No source control or removal actions are implemented under Alternative 2. Alternatives 3 through 6 address both organic and inorganic impacts and utilize monitoring in combination with removal and/or treatment technologies. Removal technologies (i.e., excavation) are included in Alternatives 3 through 6. Alternatives 3 and 4 involve excavating impacted soils/dry sediments and disposal at an offsite facility. Alternatives 5 and 6 include treatment of impacted soils/dry sediments via chemical fixation prior to 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, 3, and 5, environmental monitoring was assumed to be conducted for 30 years. For Alternatives 4 and 6, environmental monitoring was assumed to be conducted for 5 years after completion of the remedial alternative.

6.1 ALTERNATIVE 1: NO ACTION

Under Alternative 1, current access restrictions and monitoring programs at Load Line 12 will discontinue and no additional actions will be implemented. Alternative 1 provides no additional protection to human health and the environment over current conditions. This remedial alternative is required under 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

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 Load Line 12 is assumed to correspond to OHARNG established future land use for Load Line 12. An O&M period would be implemented. A 30-year O&M period is assumed for costing purposes. Prior to implementation of Alternative 2, a Remedial Design detailing 5-year reviews, continuation of current environmental monitoring, and any land use controls to address chemical contamination of soil would be developed.

A Remedial Design would be developed to address maintenance activities, monitoring requirements (such as 5-year reviews), and land use controls. The plan would address existing access restrictions. A more detailed discussion of the land use controls would be developed as part of the Remedial Design, including notification requirements for changes in land use or access restrictions. Coordination with any planned OHARNG AOC improvement and environmental monitoring activities would be necessary to ensure consistency with the Load Line 12 designated land use and RAOs for Load Line 12. Pursuant to CERCLA, a review would be conducted every 5 years as COCs would remain onsite above unrestricted (i.e., residential) preliminary cleanup goals. Five-year reviews permit evaluation of all remedy components, including land use controls. 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 ~ NATIONAL GUARD TRAINEE LAND USE

Alternative 3 consists of excavating impacted soils and/or dry sediments to meet the preliminary cleanup goals for the National Guard Trainee. Excavated soils/dry sediments would be subsequently disposed of offsite at the licensed disposal facility. Removing impacted soils/dry sediments would reduce the source of further impacts to groundwater and surface water via leaching and/or direct contact. Utilization of the AOC is assumed to correspond to OHARNG established future land use for Load Line 12. 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
- Five-year reviews.

Remedial design plan. A remedial design 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. Short-term land use controls will be developed during the active construction period to ensure a safe remediation.

Excavation. Impacted soils/dry sediments above the National Guard Trainee 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 Load Line 12 is depicted in Figure 3B-1 (Appendix 3B). Total disposal volume (i.e., ex situ) is estimated to be 1,161 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 remedial design 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. Sampling would be conducted after excavation of each area. The sampling would confirm the National Guard Trainee land use preliminary cleanup goals have been achieved. 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 design work plan.

Land use controls. Land use controls would be installed 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.

Five-year reviews. Five-year reviews and environmental monitoring would be conducted to assess potential offsite contaminant migration. Pursuant to CERCLA, a review would be conducted every 5 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 and/or dry sediment above Resident Subsistence Farmer land use preliminary cleanup goals and subsequent offsite disposal of removed materials. Achieving the residential land use applies only to chemical contamination in soils/dry sediment. The soil media will not be unrestricted until MEC issues at the AOC are addressed under the MMRP. Removing impacted soils/dry sediments would address future impacts to groundwater via leaching and/or direct contact. 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 would be relatively short and would not include an O&M period. Components of this remedial alternative include:

- Remedial Design Plan,
- Excavation,
- Handling of waste materials,
- Offsite disposal,
- Confirmatory sampling, and
- Restoration.

Remedial design plan. A remedial design plan and land use controls 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.

Excavation. Impacted soils/dry sediments would be excavated and transported to a staging area for loading into trucks. The extent of impacted soils/dry sediments at Load Line 12 above Resident Subsistence Farmer land use preliminary cleanup goals is depicted in Figure 3B-2 (Appendix 3B). Total disposal volume (i.e., ex situ) is estimated to be 18,197 yd^3. 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 AOC 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 remedial design 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. Sampling would be conducted after excavation of each area. The sampling would confirm Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. 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.

6.5 ALTERNATIVE 5: EXCAVATION OF SOILS/DRY SEDIMENTS, TREATMENT, AND OFFSITE DISPOSAL ~ NATIONAL GUARD TRAINEE LAND USE

Alternative 5 consists of excavating impacted soils/dry sediments meet the preliminary cleanup goals, National Guard Trainee land use, treatment, and subsequent offsite disposal. Removing impacted soils/dry sediments would mitigate future potential impacts to groundwater via leaching and/or direct contact. Utilization of the AOC is assumed to correspond to OHARNG established future land use for Load Line 12. Alternative 5 is similar to Alternative 3 with the exception that excavated soils/dry sediments are treated via S/S processes prior to disposal. The treatment involves S/S via chemical fixation technologies to reduce the mobility of COCs in impacted soils/dry sediments. Alternative 5 activities would require coordination with OHARNG and the US Army to minimize the health and safety risks to onsite personnel and disruption to their activities. The timeframe to complete the remedial alternative is relatively short; however, it includes an O&M period (30 years is the assumed duration for cost estimating purposes). Components of this remedial alternative include:

- Select treatment technology,
- Remedial Design Plan,
- Excavation,
- Conduct treatment,
- Handling of treated material,
- Offsite disposal of treated material,
- Confirmatory sampling,
- Restoration,
- Land use controls, and
- Five-year reviews.

Select treatment technology. Treatment is an additional feature in Alternative 5. S/S using chemical fixation has been selected as the technology for use in treating impacted soils/dry sediments and is the basis for cost estimates. Treatability studies would be performed to evaluate and confirm the effectiveness, implementability, and cost of various S/S options. Impacted soils/dry sediments would be processed using a variety of techniques and fixative admixtures to determine optimal treatment performance parameters. The evaluation of S/S herein does not preclude the addition or use of any viable technologies that may become available in the future but provides a representative treatment scenario for comparison purposes to the other remedial alternatives.

Remedial design plan. Utilizing treatability study results, a remedial design plan would be developed prior to the initiation of remedial action. This plan would detail preparation activities, the extent of the excavation, implementation and sequence of construction and treatment 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.

Excavation. Impacted soils/dry sediments would be excavated, loaded into trucks, and transported to a staging area for treatment. The extent of impacted soils/dry sediments at Load Line 12 is depicted in Figure 3B-1 (Appendix 3B). Total disposal volume (i.e., ex situ) is estimated to be 1,161 yd^3. 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. Excavation would be staged to limit impacts to current AOC 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 cover potential exposures and monitoring requirements to ensure protection.

Conduct treatment. Developing treatment capabilities onsite would begin by establishing a specific location at which to install the treatment process. Utilities and water service may be required to support treatment activities. Further preparation of the AOC also may be required including the construction of a concrete pad for treatment equipment, material storage, etc.

Chemical fixation of COCs in impacted soils/dry sediments would be conducted at a centralized treatment area. Excavated soils/dry sediments may require sieving through a coarse separation-sizing screen to remove any debris or large objects and break up soil/sediment clumps. Fixative admixtures would be mixed with soils/dry sediments at dosage rates and contact times in accordance with performance parameters determined by the treatability study. Applying and mixing admixtures to impacted soils/dry sediments could be conducted with standard construction equipment such as excavators, bulldozers, and front-end loaders. Alternatively specialized equipment such as soil mixers may be required based on the characteristics of materials involved and performance parameters. Treated soils/dry sediments would be sampled to confirm treatment goals were attained. Following successful treatment, stabilized soils/dry sediments would be loaded into trucks and shipped to an offsite disposal facility.

Handling. Treated materials would be hauled to a disposal facility by trucks lined with polyethylene sheeting (inter-model containers similarly lined also could be used) and covered with specially designed tarps or hard covers. All trucks would be inspected prior to ingressing and egressing the AOC. The appropriate bill-of-lading (in accordance with DOT regulations for shipment of treated 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 and an emergency response plan will be developed in the event of a vehicle accident.

Transportation activities would be performed in accordance with a AOC-specific TERP developed in the remedial design plan. The TERP would evaluate the vehicles to be used for transport of treated materials, the safest transportation routes (e.g., minimizing use of high traffic roads, public facilities, or secondary roads unsuited for trucks), and emergency response procedures for responding to a vehicle accident.

Offsite disposal. Treated soils/dry sediments would be disposed of at an offsite 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. Utilizing specific disposal facilities for different waste streams may reduce disposal costs.

Confirmatory sampling. Sampling would be conducted after excavation of each area. The sampling would confirm National Guard Trainee land use preliminary cleanup goals have been achieved. Areas successfully remediated would be available for appropriate restricted land use only.

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. Once treatment is complete, the treatment equipment will be decontaminated, dismantled, and removed and the treatment area restored.

Land use controls. Land use controls would be installed to restrict land use because soils/dry sediments would remain onsite above Resident Subsistence Farmer land use preliminary cleanup goals. The controls would be utilized to assure and reinforce protectiveness to human health.

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

6.6 ALTERNATIVE 6: EXCAVATION OF SOILS/DRY SEDIMENTS, TREATMENT, AND OFFSITE DISPOSAL ~ RESIDENT SUBSISTENCE FARMER LAND USE

Alternative 6 consists of excavating impacted soils/dry sediment above Resident Subsistence Farmer land use preliminary cleanup goals, treatment, and subsequent offsite disposal. Achieving this residential land use applies only to chemical contamination in soils/dry sediment. The soil media will not be unrestricted until MEC issues at the AOC are addressed under the MMRP. Removing impacted soils/dry sediments would address future potential impacts to groundwater via leaching and/or direct contact. This remedial alternative is identical to Alternative 5 with the exception that Resident Subsistence Farmer land use preliminary cleanup goals are applicable. This remedial alternative would require coordination of remediation, treatment, and monitoring activities with OHARNG and the US Army. Such coordination will minimize health and safety risks to onsite personnel and minimize disruption to their activities consistent with a safe and effective remediation. The timeframe to complete the remedial alternative is relatively short. No O&M period is included since Resident Subsistence Farmer land use preliminary cleanup goals are used to determine the completion of remediation activities. Components of this remedial alternative include:

- Select treatment technology,
- Remedial Design Plan,
- Excavation,
- Conduct treatment,
- Handling of treated materials,
- Offsite disposal of treated materials,
- Confirmatory sampling, and
- Restoration.

<u>Select treatment technology</u>. S/S via chemical fixation has been screened as the technology to treat impacted soils/dry sediments and is the basis for cost estimates. Treatability studies would be performed to evaluate and confirm the effectiveness, implementability, and cost of various S/S options. Impacted soils/dry sediments would be processed using a variety of techniques and fixative admixtures to determine optimal treatment performance parameters. The evaluation of S/S herein does not preclude the addition or use of any viable technologies that may become available in the future, but provides a representative treatment scenario for comparison purposes to the other remedial alternatives.

<u>Remedial design plan</u>. Treatability study results will be incorporated into the remedial design plan to develop treatment protocols and performance parameters. This plan also would detail preparation activities, the extent of the excavation, implementation and sequence of construction and treatment 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. Monitoring is assumed to continue for 5 years.

<u>Excavation</u>. Impacted soils/dry sediments would be excavated, loaded into trucks, and transported to a staging area for treatment. The extent of impacted soils/dry sediments at Load Line 12 above Resident Subsistence Farmer land use preliminary cleanup goals is depicted in Figure 3B-2 (Appendix 3B). Total disposal volume (i.e., ex situ) is estimated to be 18,197 yd^3. 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. Excavation would be staged to limit impacts to current AOC 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 cover potential exposures and monitoring requirements to ensure protection.

<u>Conduct treatment</u>. Developing treatment capabilities onsite would begin by establishing a specific location at which to install the treatment process. Utilities and water service may be required to support treatment activities. Further preparation of the AOC also may be required including the construction of a concrete pad for treatment equipment, material storage, etc.

Chemical fixation of COCs in impacted soils/dry sediments would be conducted at a centralized treatment area. Excavated soils/dry sediments may require sieving through a coarse separation-sizing screen to remove any debris or large objects and break up soil clumps. Fixative mixtures would be mixed with soils/dry sediments at dosage rates and contact times in accordance with performance parameters determined by the treatability study. Applying and mixing mixtures to impacted soils/dry sediments could be conducted with standard construction equipment such as excavators, bulldozers, and front end loaders. Alternatively, specialized equipment such as soil mixers may be required based on the characteristics of materials involved and performance parameters. Treated soils/dry sediments would be sampled to confirm treatment goals were attained. Following successful treatment, stabilized soils/dry sediments would be loaded into trucks and shipped to an offsite disposal facility.

Treated materials would be hauled to a disposal facility by trucks lined with polyethylene sheeting (inter-model containers similarly lined also could be used) and covered with specially designed tarps or hard covers. All trucks would be inspected prior to ingressing and egressing the AOC. The appropriate bill-of-lading (in accordance with DOT regulations for shipment of treated 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 and an emergency response plan will be developed in the event of a vehicle accident.

Transportation activities would be performed in accordance with a AOC-specific TERP developed in the remedial design plan. The TERP would evaluate the vehicles to be used for transport of treated materials, the safest transportation routes (e.g., minimizing use of high traffic roads, public facilities, or secondary roads unsuited for trucks), and emergency response procedures for responding to a vehicle accident.

<u>Offsite disposal</u>. Treated soils/dry sediments would be disposed of at an offsite 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. Utilizing specific disposal facilities for different waste streams may reduce disposal costs.

Confirmatory sampling. Sampling would be conducted after excavation of each area. The sampling would confirm National Guard Trainee land use preliminary cleanup goals have been achieved. Areas successfully remediated would be available for appropriate restricted land use only.

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. Once treatment is complete, the treatment equipment will be decontaminated, dismantled, and removed and the treatment area restored.

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. Five-year reviews would not be conducted in accordance with CERCLA 121(c)
Alternative 2 – Limited Action This remedial alternative involves 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 digging, no use of groundwater) would be developed and implemented by the US Army and OHARNG. Five-year reviews would be conducted in accordance with CERCLA 121(c)
Alternative 3 – Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soils/dry sediments above National Guard Trainee land use preliminary cleanup goals and 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 ensure land use preliminary cleanup goals have been achieved. Areas successfully remediated would be backfilled with clean soils, if appropriate. 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., soils, groundwater, and sediment) would be conducted to assess potential for offsite contaminant migration. The remedial action includes an O&M period. Five-year reviews would be conducted in accordance with CERCLA 121(c)
Alternative 4 – Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use This remedial alternative involves the removal and transportation of chemical contaminants in soils/dry sediments 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 ensure Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Areas successfully remediated would be backfilled with clean soils. Environmental monitoring (i.e., groundwater) would be conducted to under the auspices of the Ohio EPA Director's Findings and Orders. Alternative 4 does not include O&M as residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative

Table 6-1. Summary of Remedial Alternatives (continued)

Alternative 5 – Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use This remedial alternative involves the removal and transportation of impacted media above National Guard Trainee land use preliminary cleanup goals for treatment and offsite disposal. Impacted soils/dry sediments would be excavated and transported to a central treatment area. Treatment would consist of mixing stabilization/solidification admixtures with excavated soils/dry sediments per the performance parameters established through a treatability study. Sampling will be conducted to ensure successful treatment. Treated soils/dry sediments would then be transported to an offsite disposal facility licensed and permitted to accept the wastes. Confirmation sampling would be conducted to ensure land use preliminary cleanup goals have been achieved. Land use controls would be instituted including existing access restrictions; restrictions to prohibit changes in land uses; and periodic inspection of the AOC to determine any changes in land use. Periodic environmental monitoring (i.e., groundwater and surface water) would be conducted to assess potential for offsite contaminant migration. The remedial action includes an O&M period. Five-year reviews would be conducted in accordance with CERCLA 121(c)
Alternative 6 – Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use This remedial alternative involves the removal and transportation of chemical contamination in soils/dry sediments above Resident Subsistence Farmer land use preliminary cleanup goals for treatment and offsite disposal. Impacted soils/dry sediments would be excavated and transported to a staging area for treatment. Impacted soils/dry sediments would be excavated and transported to a central treatment area. Treatment would consist of mixing stabilization/solidification admixtures with excavated soils/dry sediments per the performance parameters established through a treatability study. Sampling will be conducted to ensure successful treatment. Treated soils/dry sediments would then be transported to an offsite disposal facility licensed and permitted to accept the wastes. Confirmation sampling would be conducted to ensure Resident Subsistence Farmer land use preliminary cleanup goals have been achieved. Environmental monitoring (i.e., groundwater) would be conducted under the auspices of the Ohio EPA Director's Findings and Orders. Alternative 6 does not include O&M as residential land use preliminary cleanup goals are attained through remedial actions conducted under this remedial alternative

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

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7.0 ANALYSIS OF REMEDIAL ALTERNATIVES

7.1 INTRODUCTION

This section presents a detailed analysis of the six 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 Load Line 12. 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 section 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 bioaccumulate;
- 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 were 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 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;
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 AOC 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 LL12 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 Load Line 12 are presented below. Each relevant set of alternatives are described and evaluated against the criteria outlined in Section 7.1.

7.2 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVES FOR LOAD LINE 12

Six remedial alternatives were retained for Load Line 12:

- Alternative 1: No Action (i.e., no remedial actions or controls conducted onsite);
- Alternative 2: Limited Action (e.g., as preparation of Remedial Design);
- Alternative 3: Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use;
- Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use;
- Alternative 5: Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use; and
- Alternative 6: Excavation of Soils/Dry Sediments, Treatment, 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. Also, details of this analysis are summarized in Table 7-1.

7.2.1 Alternative 1: No Action

Under this alternative, impacted soils and sediments 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, Load Line 12 is assumed to be utilized in accordance with the OHARNG Integrated National Resources Management Plan (OHARNG 2001) and consistent with the OHARNG established future land use for Load Line 12, which forms the basis for the exposure scenarios evaluated under restricted and residential land use (Section 3.2).

7.2.1.1 Overall Protection of Human Health and the Environment

The HHRA for Load Line 12 evaluated risks for two soil EUs (Eastern Soil Aggregate and Western Soil Aggregate) and five sediment EUs (Active Area Channel, North of Active Area, Main Ditch, Upgradient Location, and West Ditches).

Alternative 1 is protective of human health for the anticipated OHARNG future land use for the Eastern Soil Aggregate, the Active Area Channel, North of the Active Area, the Upgradient Location, and the West Ditches. The HHRA for Load Line 12 indicates potential future human health risks are below the target risk of 1E-05 and within or below the CERCLA acceptable range of 1E-06 to 1E-04 under the representative land use scenario (represented by a National Guard Trainee) at these EUs. The potential future human health HIs are also below the target level of 1 for non-carcinogenic compounds. Alternative 1 is also protective of human health for anticipated OHARNG future land use for the Western Soil Aggregate. The ILCR calculated for the Western Soil Aggregate in the HHRA presented in the March 2004 Phase II RI Report is 3E-05. The potential future human health risk also could exceed an HI of 1 for non-carcinogenic compounds at the Western Soil Aggregate. The HHRA for Load Line 12 was conducted prior to the FWHHRAM (USACE 2004b) and evaluated a National Guard Trainee exposed to surface soil (0-1 ft BGS) 180 days/year. This exposure scenario produced larger risks than that for actual National Guard Trainees as recommended in the FWHHRAM (assumed to be exposed 1 weekend per month and 2 weeks per year [39 days/year]). Exposure to sediment in the HHRA (28 days/year) was more similar to the FWHHRAM recommendation of 39 days/year. Exposure parameters recommended in the FWHHRAM were developed following land use recommendations for RVAAP in conjunction with OHARNG, Ohio EPA, and USACE to reflect estimates of exposure that are reasonable and protective for receptors at RVAAP based on most recent Ohio EPA and USEPA guidance. The EPCs of all COCs identified for this receptor are below background (inorganics) or preliminary cleanup goals (organics); therefore, this alternative is protective of human health for the restricted access scenario for the Western Soil Aggregate.

Potential human health risks from exposure to soil and sediment (via ingestion, dermal contact, and inhalation) under the no action alternative for anticipated future OHARNG land use are summarized below for these five EUs:

- Surface Soil (0-1 ft BGS)
  - Eastern Soil Aggregate HI = 0.002, ILCR = 3E-07
  - Western Soil Aggregate HI = 5, ILCR = 3E-05
- Subsurface Soil (1-7 ft BGS)
  - No subsurface soil in Eastern Soil Aggregate
  - Western Soil Aggregate HI = 0.009, ILCR = 2E-06
- Sediment
  - Active Area Channel HI = 0.008, ILCR = 1E-07
  - North of Active Area HI = 0.001, ILCR = 2E-07
  - Upgradient Location HI = 0.001, ILCR = 5E-06

- West Ditches HI = 0.008, ILCR = 8E-07

Alternative 1 may not be protective of human health for the anticipated future OHARNG land use for the Main Ditch. Results of the HHRA indicate a potential future human health ILCR of 2E-05 (slightly above the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04) under the representative land use scenario (represented by a National Guard Trainee) at this EU. The potential future human health HI (0.2) is below 1.

Alternative 1 is protective of human health for the residential land use scenario (represented by the Resident Subsistence Farmer) for the Eastern Soil Aggregate, the Active Area Channel, and North of the Active Area. The HHRA for Load Line 12 indicates potential future human health risks are below the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the residential land use scenario at these EUs. The potential future human health HIs are equal to or below the target level of 1 for non-carcinogenic compounds at these EUs. Potential human health risks from exposure to soil and sediment (via ingestion, dermal contact, and inhalation) under the no action alternative for residential land use are summarized below for these two EUs:

- Surface Soil (0-1 ft BGS)
    - Eastern Soil Aggregate HI = 0.01 (adult) and 0.1 (child), ILCR = 2E-06 (adult) and 8E-07 (child)
    - No subsurface soil (1-7 ft BGS) in Eastern Soil Aggregate
- Sediment
    - Active Area Channel HI = 0.2 (adult) and 1 (child), ILCR = 4E-06 (adult) and 2E-06 (child)
    - North of Active Area HI = 0.03 (adult) and 0.2 (child), ILCR = 6E-06 (adult) and 3E-06 (child)

Alternative 1 is not protective of human health for the residential land use scenario for the Western Soil Aggregate, Main Ditch, Upgradient Location, and West Ditches. The HHRA for Load Line 12 indicates potential future human health risks could exceed the target risk of 1E-05 and are at the upper bound of the CERCLA acceptable range of 1E-06 to 1E-04 under the residential land use scenario (represented by a Resident Subsistence Farmer). The potential future human health risk also could exceed an HI of 1 for non-carcinogenic compounds. Potential human health risks from exposure to soil and sediment (via ingestion, dermal contact, and inhalation) under the no action alternative for residential land use are summarized below for these three EUs:

- Surface Soil (0-1 ft BGS)
    - Western Soil Aggregate HI = 2 (adult) and 7 (child), ILCR = 1E-04 (adult) and 8E-05 (child)
- Subsurface Soil (1-7 ft BGS)

  - Western Soil Aggregate HI = 0.3 (adult) and 1 (child), ILCR = 7E-05 (adult) and 5E-05 (child)
- Sediment
  - Main Ditch HI = 7 (adult) and 30 (child), ILCR = 7E-04 (adult) and 8E-05 (child)
  - Upgradient Location HI = 0.04 (adult) and 0.3 (child), ILCR = 2E-04 (adult) and 8E-05 (child)
  - West Ditches HI = 0.3 (adult) and 2 (child), ILCR = 3E-05 (adult) and 3E-05 (child)

The ILCRs estimated for exposure to sediment in the Upgradient Location are associated primarily with arsenic. The ILCRs for arsenic (3E-05 for adult and child) are similar to the ILCRs estimated for the background criteria for this metal. The ILCRs estimated for the remaining COPCs in sediment at the Upgradient Location (4E-06) are less than 1E-05. Therefore, while Alternative 1 is not protective for the residential land use scenario at this EU, the potential ILCR is associated primarily with naturally occurring arsenic.

Alternative 1 provides no additional protection to human health and the environment over these baseline conditions. Soil and sediment that pose potentially unacceptable risks under potential future land use scenarios would not be remediated.

There would be no mitigation of identified risks to ecological receptors from COPECs in soil and sediment under this alternative; however, considering the rather low concentrations of many COECs remediation for ecological risk is not justified at Load Line 12. There would be no loss of vegetation, disruption of soil or sediment, or impairment of ponds from increased erosion, leaching, or resuspension resulting from remedial actions. Aquatic habitat in Load Line 12 ponds would not decline in quality under Alternative 1.

7.2.1.2 <u>Compliance with ARARs</u>

Potential ARARs for remediation of soils/dry sediments at Load Line 12 are presented in Chapter 4. These enforceable standards would be protective of representative receptors under both National Guard Trainee and Resident Subsistence Farmer land use that could be exposed to COCs at Load Line 12. 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 <u>Long-Term Effectiveness and Permanence</u>

Alternative 1 includes no long-term management measures to prevent exposures to or the spread of contamination. Existing AOC 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. Under future National Guard Trainee and Resident Subsistence Farmer scenarios, there are potentially unacceptable risks to human health and the environment in certain aggregates, since the impacted soils and sediments would remain in place without controls.

7.2.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No reduction in contaminant toxicity, mobility, or volume is achieved since no treatment process is proposed under this alternative. Also, no monitoring would be performed to evaluate potential decrease or mobility of contaminants at Load Line 12.

7.2.1.5 Short-Term Effectiveness

No significant short-term human health risks are associated with Alternative 1 beyond baseline conditions. Correspondingly, no additional short-term health risks are posed to the community 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 actions are proposed under this alternative.

7.2.1.7 Cost

The present value cost to complete Alternative 1 is zero. As discussed earlier, the no action alternative does not meet NCP threshold evaluation criteria (overall protection of human health and the environment/compliance with ARARs). Therefore, Alternative 1 is not likely to be selected as the preferred remedial alternative for Load Line 12.

7.2.2 Alternative 2: Limited Action

Alternative 2 maintains the current status of the property and includes land use controls and 5-year reviews to identify potential exposures and changes in the nature or extent of AOC contamination. Land use controls would be implemented under a Remedial Design.

Pursuant to CERCLA, a review would be conducted every 5 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 may not be protective for a residential land use scenario. Alternative 2 is protective of human health for the Eastern Soil Aggregate, the Active Area Channel, North of the Active Area, the Upgradient Location, and the West Ditches. The HHRA for Load Line 12 indicates potential future human health risks are below the target risk of 1E-05 and within or below the CERCLA acceptable range of 1E-06 to 1E-04 under the restricted land use scenario (represented by a National Guard Trainee) at these EUs. The potential future human health HIs are also below the target level of 1 for non-carcinogenic compounds. Alternative 2 is also protective of human health for the representative future land use for the Western Soil Aggregate. The ILCR calculated for the Western Soil Aggregate in the HHRA presented in the March 2004 Phase II RI Report is 3E-05. The potential future human health risk also could exceed an HI of 1 for non-carcinogenic compounds at the Western Soil Aggregate. The HHRA for Load Line 12 was conducted prior to the FWHHRAM (USACE 2004b) and evaluated a National Guard Trainee exposed to surface soil (0-1 ft BGS) 180 days/year. This exposure scenario produced larger risks than that for actual National Guard Trainees as recommended in the FWHHRAM [assumed to be exposed 1 weekend per month and 2 weeks per year (39 days/year)]. Exposure to sediment in the HHRA (28 days/year) was more similar to the FWHHRAM recommendation of 39 days/year. The EPC of all COCs identified for this receptor are below background (inorganics) or preliminary cleanup goals (organics); therefore, this alternative is protective of human health for the restricted access scenario for the Western Soil Aggregate.

Alternative 2 may not be protective of human health for anticipated OHARNG land use (represented by a National Guard Trainee) for the Main Ditch with the assumption that land use controls will be implemented and maintained. Results of the HHRA indicate potential future human health ILCR of 2E-05 (slightly above the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04) under the representative land use scenario at this EU. The potential future human health HI (0.2) is below 1. However, Load Line 12 is assumed to be utilized in accordance with the OHARNG Integrated National Resources Management Plan (OHARNG 2001) and consistent with OHARNG established future land use for Load Line 12, which forms the basis for the exposure scenarios evaluated under restricted.

There would be no mitigation of identified risks to ecological receptors from COPECs in soil and sediment under this alternative; however, considering the rather low concentrations of many COECs, remediation for ecological risk is not justified at Load Line 12. There would be no loss of vegetation, disruption of soil or sediment, or impairment of ponds from increased erosion, leaching, or resuspension resulting from remedial actions. Aquatic habitat in Load Line 12 ponds would not decline in quality under this alternative.

7.2.2.2 <u>Compliance with ARARs</u>

Potential ARARs for remediation of soils/dry sediments at Load Line 12 are presented in Chapter 4. These enforceable standards would be protective of representative receptors under both the National Guard Trainee and residential land use that could be exposed to COCs at Load Line 12. 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 <u>Long-Term Effectiveness and Permanence</u>

Alternative 2 is protective in the long-term in aggregates stated in the HHRA. The alternative relies on land use controls and maintenance of limited AOC 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. Land use controls could potentially fail. However, with appropriate documentation and procedures, land use controls can be reasonably expected to be successful in protecting human health and the environment while preserving the land uses required for operation of Load Line 12. Currently, access restrictions are in place at Load Line 12. The AOC is surrounded by a chain-link fence with a locked gate. Alternative 2 will bolster these existing controls by installing signs and developing and instituting a Remedial Design.

Because contaminants would remain onsite at concentrations above Resident Subsistence Farmer land use preliminary cleanup goals, reviews would be conducted once every 5 years per CERCLA requirements. These reviews would evaluate data obtained from ongoing monitoring, determine the presence and behavior of contaminants, and review land use and engineering controls to ensure effectiveness.

7.2.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No reduction in contaminant toxicity, mobility, or volume is achieved since no treatment process is proposed under this alternative.

7.2.2.5 Short-Term Effectiveness

Alternative 2 would not pose additional short-term risks to the community. The alternative's measures would require 0 years to complete and includes an O&M period, monitoring, and 5-year reviews.

7.2.2.6 Implementability

Land use controls and AOC improvements are technically implementable. No technical difficulties are anticipated in establishing or maintaining monitoring programs, access controls, or cover material. Access restrictions are currently implemented facility-wide and at Load Line 12. Implementing proposed land use controls and improvements under Alternative 2 would bolster and access restrictions already existing onsite.

7.2.2.7 Cost

The present value cost to complete Alternative 2 is approximately $209,194 (in base year 2005 dollars with a 3.1% discount factor). O&M costs (for land use controls and monitoring) are estimated for a 30-year period for costing purposes. Implementing land use controls, Load Line 12's Remedial Design, and CERCLA 5-year reviews are included in this cost. See Appendix 7 for a detailed description of Alternative 2 costs.

7.2.3 Alternative 3: Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use

Alternative 3 includes excavation and offsite disposal of impacted dry sediments above National Guard Trainee preliminary cleanup goals. An estimated 1,161 yd^3 (ex situ) of arsenic-impacted sediment would be excavated and shipped offsite to a permitted disposal facility. Other technologies included in this alternative are land use controls, monitoring, and handling.

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 land use at Load Line 12 as represented by the National Guard Trainee scenario.

The HHRA for Load Line 12 indicates potential future human health risks are below the target risk of 1E-05 and below or within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the National Guard Trainee land use scenario for surface soil (0-1 ft BGS) at the Eastern Soil Aggregate and sediment at the Active Area Channel, North of the Active Area, the Upgradient Location, and the West Ditches. Potential future human health HIs are below 1. The ILCR calculated for the Western Soil Aggregate in the HHRA presented in the March 2004 Phase II RI Report is 3E-05 and the HI is 5. The HHRA for Load Line 12 was conducted prior to the FWHHRAM (USACE 2004b) and evaluated a National Guard Trainee exposed to surface soil (0-1 ft BGS) 180 days/year. This exposure scenario produced larger risks than that for National Guard Trainees as recommended in the FWHHRAM (assumed to be exposed 39 days/year). The EPC of all COCs identified for this receptor are below background (inorganics) or preliminary cleanup goals (organics). Therefore, the no action alternative is protective of human health for the restricted access scenario for these EUs and no excavation is included for these areas in Alternative 3.

The no action alternative may not be protective of human health for the most likely future land use for the Main Ditch. Results of the HHRA indicate potential future human health ILCR of 2E-05 (slightly above the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04) under the restricted land use scenario (represented by a National Guard Trainee) at this EU. The potential future human health HI (0.2) is below 1. Exposure to sediment in the HHRA (28 days/year) was more similar to the FWHHRAM recommendation of 39 days/year and COCs are present in sediment above preliminary cleanup goals.

Alternative 3 includes removal of sediment at the Main Ditch to meet the National Guard Trainee land use preliminary risk goal of 1E-05. Areas of sediment removal are shown in Figure 3B-1 (Appendix 3B).

The HHRA estimated potential future human health risks for the restricted land use scenario (represented by a National Guard Trainee) for the no action alternative (i.e., pre-remediation). Recall that arsenic was the only FS COC for sediment identified for evaluation in the FS alternatives for the National Guard Trainee (see Section 3.3.5.1 and Table 3-10). The removal of all sediment locations in the Main Ditch with arsenic concentrations that exceed its preliminary cleanup goal of 31 mg/kg provides reasonable certainty that the post-remediation ILCR for arsenic will be below the threshold of 1E-05 and the post-remediation HQ for arsenic will be below the threshold of 1.0 for the representative receptor (National Guard Trainee). This reduction in ILCR and HQ for arsenic, coupled with the fact that EPCs for all other sediment COCs are already below their respective preliminary remediation goals, 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 National Guard Trainee. Therefore, this alternative provides overall protection for human health. Contaminants would remain above Resident Subsistence Farmer land use preliminary cleanup goals. Exposure would be prevented as long as land use controls are maintained. If land use controls fail, risks may exceed the target risk for the Resident Subsistence Farmer land use receptor.

The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC. There would be a temporary loss of vegetation, disruption of soil or sediment, or impairment of ponds from increased erosion, leaching, or resuspension resulting from remedial actions. With erosion and other engineering precautions, the adverse effects of these impacts would be mitigated. Aquatic habitat in Load Line 12 ponds would eventually increase in quality due to remedial actions under this alternative.

7.2.3.2 Compliance with ARARs

Potential ARARs for remediation of sediments at Load Line 12 are presented in Chapter 4. These enforceable standards would be protective of representative receptors under National Guard Trainee land use that could be exposed to COCs at Load Line 12. 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 National Guard Trainee land use. However, it relies on land use controls to eliminate or reduce exposures to receptors and is thereby reliant on the adequacy and reliability of land use controls. Although the potential exists for land use controls to fail, it is reasonable to expect that, with appropriate documentation and procedures, land use controls can be successfully implemented and would be effective in protecting human health and the environment.

Under Alternative 3, contaminants will remain onsite above preliminary cleanup goals for residential land use. Reviews will be conducted at least once every 5 years for 30 years, pursuant to CERCLA requirements. The purpose of these reviews will be to evaluate data obtained from ongoing monitoring, to provide information on the presence and behavior of contaminants, and to ensure engineering and land use controls are effective.

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 dry sediment. 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 sediment 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 1 month to complete, followed by 30 years of O&M. Upon the completion of the excavation activities, Load Line 12 would be released for National Guard Trainee 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 Load Line 12. 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 National Guard Trainee land use. The DOT regulates the transport of most hazardous materials. 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. Load Line 12 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 $364,789 (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 with Offsite Disposal ~ Resident Subsistence Farmer Land Use

Alternative 4 includes excavation and offsite disposal to remove impacted soils and dry sediment exceeding residential land use cleanup goals (represented by the subsistence farmer scenario). An estimated 18,197 yd^3 (ex situ) of SVOC-, PCB-, and inorganic-contaminated soil and sediment would be excavated and shipped offsite to a permitted disposal facility. Other technologies required would include short-term land use controls, monitoring, and waste handling.

7.2.4.1 Overall Protection of Human Health and the Environment

In general, the long-term protectiveness of this alternative is high. The HHRA for Load Line 12 indicates potential future human health risks are below the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04 under the residential land use scenario at the Eastern Soil Aggregate, the Active Area Channel, and North of the Active Area. The potential future human health HIs are equal to or below the target level of 1 for non-carcinogenic compounds at these EUs.

The HHRA for Load Line 12 indicates potential future human health risks could exceed the target risk of 1E-05 and are at the upper bound of the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the residential land use scenario (represented by the Resident Subsistence Farmer scenario) for the Western Soil Aggregate, Main Ditch, Upgradient Location, and West Ditches. The potential future human health risk also could exceed an HI of 1 for non-carcinogenic compounds at these EUs. Alternative 4 includes removal of soil to meet the media-specific preliminary cleanup goals in surface soil (0-1 ft BGS), subsurface soil (1-7 ft BGS), and sediment. Removing soil/sediment containing contaminants above media-specific 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 ILCR from arsenic will remain in the range of 2E-05 to 3E-05).

The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC. There would be a temporary loss of vegetation, disruption of soil or sediment, or impairment of ponds from increased erosion, leaching, or resuspension resulting from remedial actions. With erosion and other engineering precautions, the adverse effects of these impacts would be mitigated.

Aquatic habitat in Load Line 12 ponds would eventually increase in quality due to remedial actions under this alternative.

7.2.4.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at Load Line 12 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 Load Line 12. 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 of soils and dry sediment at Load Line 12. All soils/sediment above Resident Subsistence Farmer land use preliminary cleanup goals would be excavated and transported offsite for disposal, thereby mitigating risks to human health and the environment. Land use controls will not be required upon the completion of the removal activities. Therefore, Alternative 4 is not dependent on land use controls.

The AOC will undergo sampling to confirm the removal of the targeted SVOCs, PCBs, and inorganics. Subsequent CERCLA 5-year reviews , land use controls, and O&M sampling would not be required for this alternative.

7.2.4.4 Reduction of Toxicity, Mobility, or Volume through Treatment

No reduction in the toxicity, mobility, or volume of impacted soils is achieved by this alternative since no treatment is performed.

7.2.4.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 4 includes the potential for worker exposure during excavation as well as the exposure to the community during transportation of soils/sediment. Workers would follow a health and safety plan and wear appropriate PPE to minimize exposures. Mitigation measures would be used to minimize short-term impacts, such as erosion and dust control during construction.

Excavated soils and dry sediment would be transported by truck to a disposal facility. Risks associated with handling waste materials will be mitigated by inspecting vehicles before and after use, decontaminating when needed, covering transported waste, observing safety protocols, following pre-designated routes, and limiting the distance wastes are transported in vehicles. Transportation risks (e.g., from continuous leaks) increase with distance and volume. Transportation of impacted 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 accidents.

Alternative 4 remedial actions are estimated to require less than 3 months to complete. Upon the completion of impacted soil/sediment removal, Load Line 12 would be released for residential land use.

7.2.4.6 Implementability

Technically and administratively, this alternative is implementable. Excavating impacted soils and sediment involves conventional construction activities such as temporary roads construction and onsite truck transport. Multiple disposal facilities are available that can accept the waste. Construction and operation of the Alternative 4 components would be straightforward with resources readily available to accomplish remedial activities. However, special engineering techniques may be required during construction activities to deal with potential MEC issues at Load Line 12. Borrow sites for backfill and soil cover have not been selected but are anticipated to be locally available.

The acceptability of Alternative 4 would be affected by the administrative requirements for transport and disposal. The DOT would regulate the transport of waste materials. Local engineering departments would be consulted to evaluate impacts of 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. 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 Alternative 4 implementation difficulty but will also reduce the risks to onsite personnel.

7.2.4.7 Cost

The present value cost to complete Alternative 4 is approximately $1,794,453 (in base year 2005 dollars with a 3.1% discount factor). Removal, disposal, and confirmation sampling are included in this cost. See Appendix 7 for a detailed description of Alternative 4 costs.

7.2.5 Alternative 5: Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use

Alternative 5 includes excavation, treatment, and offsite disposal of impacted dry sediments above National Guard Trainee preliminary cleanup goals. The inorganically impacted sediment at Load Line 12 would be treated by S/S via chemical fixation. Treated soils would be shipped to a permitted, offsite disposal facility. Excavation, use of road cover, monitoring, and handling are components of this alternative.

7.2.5.1 Overall Protection of Human Health and the Environment

In general, the long-term protectiveness of this alternative is high for the anticipated OHARNG land use at Load Line 12 represented by the National Guard Trainee.

The HHRA for Load Line 12 indicates potential future human health risks are below the target risk of 1E-05 and below or within the CERCLA acceptable range of 1E-06 to 1E-04 ILCR under the National Guard Trainee land use scenario for surface soil (0-1 ft BGS) at the Eastern Soil Aggregate and sediment at the Active Area Channel, North of the Active Area, the Upgradient Location, and the West Ditches. Potential future human health risks HIs are below 1. The ILCR calculated for the Western Soil Aggregate in the HHRA presented in the March 2004 Phase II RI Report is 3E-05 and the HI is 5. The HHRA for Load Line 12 was conducted prior to the FWHHRAM (USACE 2004b) and evaluated a National Guard Trainee exposed to surface soil (0-1 ft BGS) 180 days/year. This exposure scenario produced larger risks than that for National Guard Trainees as recommended in the FWHHRAM (assumed to be exposed 39 days/year). The EPC of all COCs identified for this receptor are below background (inorganics) or preliminary cleanup goals (organics). Therefore, the no action alternative is protective of human health for the restricted access scenario for these EUs and no excavation is included for these areas in Alternative 5.

The no action alternative may not be protective of human health for the most likely future land use for the Main Ditch. Results of the HHRA indicate potential future human health ILCR of 2E-05 (slightly above the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04) under the restricted land use scenario (represented by a National Guard Trainee) at this EU. The potential future human health HI (0.2) is below 1.

Alternative 5 includes removal of sediment and treatment to meet the restricted land use risk goal of 1E-05 in sediment. Treated sediment will be disposed of offsite. Areas of sediment removal are shown in Figure 3B-1 (Appendix 3B).

The HHRA estimated potential future human health risks for the restricted land use scenario (represented by a National Guard Trainee) for the no action alternative (i.e., pre-remediation). Recall that arsenic was the only FS COC for sediment identified for evaluation in the FS alternatives for the National Guard Trainee (see Section 3.3.5.1 and Table 3-10). The removal of all sediment locations in the Main Ditch with arsenic concentrations that exceed its preliminary cleanup goal of 31 mg/kg provides reasonable certainty that the post-remediation ILCR for arsenic will be below the threshold of 1E-05 and the post-remediation HQ for arsenic will be below the threshold of 1.0 for the representative receptor (National Guard Trainee). This reduction in ILCR and HQ for arsenic, coupled with the fact that EPCs for all other sediment COCs are already below their respective preliminary remediation goals, 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 National Guard Trainee. Therefore, this alternative provides overall protection for human health. Contaminants would remain above residential land use preliminary cleanup goals. Exposure would be prevented as long as land use controls are maintained. If land use controls fail, risks may exceed the target risk for the residential land use receptor.

The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC. There would be a temporary loss of vegetation, disruption of soil or sediment, or impairment of ponds from increased erosion, leaching, or resuspension resulting from remedial actions. With erosion and other engineering precautions, the adverse effects of these impacts would be mitigated. Aquatic habitat in Load Line 12 ponds would eventually increase in quality due to remedial actions under this alternative.

7.2.5.2 Compliance with ARARs

Potential ARARs for remediation of dry sediments at Load Line 12 are presented in Chapter 4. These federally enforceable standards would be protective of representative receptors under National Guard Trainee land use who could be exposed to COCs at Load Line 12. There are no identified chemical-specific or location-specific ARARs identified for Alternative 5. Action-specific ARARs would not apply unless an action is taken.

7.2.5.3 Long-Term Effectiveness and Permanence

Similar to Alternative 3, Alternative 5 is protective in the long term for National Guard Trainee land use. Alternative 5 is reliant on land use controls to eliminate or reduce exposures to receptors associated with National Guard Trainee land use. Therefore, the long-term effectiveness of this alternative is directly related to the adequacy and reliability of these land use controls. Although the potential exists for land use controls to fail, it is reasonable to expect that, with appropriate documentation and procedures, land use controls can be successfully implemented and would be effective in protecting human health and the environment. Load Line 12 currently has access restrictions such as a chain-link fence surrounding the AOC. Consequently, it is reasonable to believe land use controls may be reliably implemented onsite.

Under Alternative 5, contaminants will remain onsite above residential land use preliminary cleanup goals. Reviews will be conducted at least once every 5 years for 30 years pursuant to CERCLA requirements. The purpose of these reviews will be to evaluate data obtained form ongoing monitoring, to provide information on the presence and behavior of contaminants, and to ensure engineering controls and land use controls are retaining effectiveness.

7.2.5.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 5 includes S/S treatment to immobilize contaminants within a chemical fixated dry sediment matrix. By reducing mobility, the bioavailability of the contaminants may also be reduced. Toxicity is generally unchanged by S/S treatment technologies. This treatment may result in overall waste volume increase.

7.2.5.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 5 is similar to Alternatives 3 and 4 with the exception of potential worker exposure during treatment operations. The overall risk in implementing Alternative 5 is increased due to the handling of wastes during treatment. When performing S/S treatment, 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 also would minimize short-term impacts.

Alternative 5 remedial actions are estimated to require 2 months to implement, and would include a O&M period (including periodic monitoring). Following completion of excavation, treatment, and restoration, Load Line 12 would be released for National Guard Trainee land use and a 5-year review would be conducted pursuant to CERCLA regulations.

7.2.5.6 Implementability

Effectiveness and implementation concerns for this alternative include:

- The ability of the S/S process to meet treatment goals,
- Logistical and technical problems for pilot demonstrations and scale-up to full-scale operations, and
- Local resistance to onsite treatment.

Alternative 5 is considered to be technically implementable provided treatment performance criteria can be attained. Commercial S/S technologies are currently available, although AOC-specific treatability/pilot studies would be required prior to remedial action to determine applicability to Load Line 12.

Careful planning would be needed between remedial action planners and OHARNG to minimize disruptions and/or impacts to OHARNG operations. Access routes for heavy equipment to remediation areas would be selected to minimize disruption. Additional steps would be undertaken to minimize hazards posed to onsite personnel. This type of planning will increase the implementation difficulty of Alternative 5 but also reduce risks to onsite personnel.

Other aspects of this alternative, such as excavation and truck transport of soil, are conventional activities in construction projects of this kind. Standard excavation and construction equipment would be used to remove contaminated material. Resources are readily available for removing impacted soils and providing backfill over excavated areas. Special engineering techniques may be required during construction activities to deal with potential MEC issues at Load Line 12. Borrow sites for backfill and soil cover have not been selected but are anticipated to be locally available.

The acceptability of Alternative 5 would be affected by the administrative requirements for transport and disposal. The DOT regulates the transport of most hazardous materials. Consultation with the local engineering departments would be undertaken to evaluate the impact of the truck traffic on the roads from the RVAAP.

7.2.5.7 Cost

The present value cost to complete Alternative 5 is approximately $655,064 (in base year 2005 dollars with a 3.1% discount factor). O&M including monitoring is estimated for a 30-year period. The imposition of land use controls is included in this cost. In addition, 5-year reviews are required throughout the costing period. See Appendix 7 for a detailed description of Alternative 5 costs.

7.2.6 Alternative 6. Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use

Alternative 6 includes excavation combined with treatment and offsite disposal to meet preliminary cleanup goals for residential land use. Impacted soils and sediment at Load Line 12 would be treated by S/S via chemical fixation. Treated soils would be shipped to a permitted, offsite disposal facility. Excavation, use of road cover, and handling are components of this alternative.

7.2.6.1 Overall Protection of Human Health and the Environment

In general, the long-term protectiveness of this alternative is high. The HHRA for Load Line 12 indicates potential future human health risks are below the target risk of 1E-05 and within the CERCLA acceptable range of 1E-06 to 1E-04 under the residential land use scenario at the Eastern Soil Aggregate, the Active Area Channel, and North of the Active Area. The potential future human health HIs are equal to or below the target level of 1 for non-carcinogenic compounds at these EUs.

The HHRA for Load Line 12 indicates potential future human health risks could exceed the target risk of 1E-05 and are at the upper bound of the CERCLA acceptable range of 1E-06 to 1E-04 under the residential land use scenario (represented by a Resident Subsistence Farmer) for the Western Soil Aggregate, Main Ditch, Upgradient Location, and West Ditches. The potential future human health risk also could exceed an HI of 1 for non-carcinogenic compounds at these EUs.

Alternative 6 includes removal of soil and sediment and treatment to meet the residential land use preliminary cleanup goals. Treated soil/sediment will be disposed of offsite. Removing and treating soil and sediment containing contaminants above media-specific 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 ILCR from arsenic will remain in the range of 2E-05 to 3E-05).

The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC. There would be a temporary loss of vegetation, disruption of soil or sediment, or impairment of ponds from increased erosion, leaching, or resuspension resulting from remedial actions. With erosion and other engineering precautions, the adverse effects of these impacts would be mitigated. Aquatic habitat in Load Line 12 ponds would eventually increase in quality due to remedial actions under this alternative.

7.2.6.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at Load Line 12 are presented in Chapter 4. These federally enforceable standards would be protective of representative receptors under both National Guard Trainee and residential land use who could be exposed to COCs at Load Line 12. 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.

7.2.6.3 Long-Term Effectiveness and Permanence

The excavation and removal of impacted soils/sediment would result in a permanent reduction in AOC risks. Excavation of soils/sediment would be protective of human health under future use scenarios without dependence on land use controls. Since all materials that pose an unacceptable health risk would be removed and placed in a permanent disposal facility after treatment, Alternative 6 is considered permanent. Consequently, no long-term management of AOC would be required.

The AOC will undergo confirmation sampling during remedial activities to confirm the removal of the targeted SVOCs, PCBs, and inorganics in soils and sediment. Subsequent CERCLA 5-year reviews, land use controls, and O&M sampling will not be required for this alternative.

7.2.6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Alternative 6 includes S/S treatment to immobilize contaminants within a chemical fixated dry sediment matrix. By reducing mobility, the bioavailability of the contaminants may also be reduced. Toxicity is generally unchanged by S/S treatment technologies. This treatment may result in overall waste volume increase.

7.2.6.5 Short-Term Effectiveness

Short-term effectiveness of Alternative 6 is similar to Alternative 5, including potential worker exposure during treatment process. The overall risk in implementing this alternative is increased versus Alternatives 3 and 4 because of the handling of wastes during treatment. When performing treatment, 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 be used to minimize short-term impacts.

Remedial actions would require less than 6 months to implement, and would not include an O&M period. Following completion of excavation, treatment, and restoration, Load Line 12 would be released for residential land use.

7.2.6.6 Implementability

Effectiveness and implementation concerns for this alternative include:

- The ability of the S/S process to meet treatment goals,
- Logistical and technical problems for pilot demonstrations and scale-up to full-scale operations, and
- Local resistance to onsite treatment.

Alternative 6 is considered to be technically implementable provided treatment performance criteria can be attained. Commercial S/S technologies are currently available, although AOC-specific treatability/pilot studies would be required prior to remedial action to determine applicability to Load Line 12.

Careful planning between remedial action planners and OHARNG would be required to minimize disruptions and/or impacts to OHARNG operations. Establishing access routes for heavy equipment to remediation areas would minimize disruption. Additional steps would be taken to minimize hazards posed to onsite personnel. This type of planning will increase the relative difficulty of implementing Alternative 6 but also reduce risks to onsite personnel.

Other aspects of this alternative, such as excavation and waste handling, are conventional construction activities. Standard excavation and construction equipment would be used to remove impacted material with suitable resources readily available. Special engineering techniques may be required during construction activities to deal with potential MEC issues at Load Line 12. Borrow sites for backfill and soil cover have not been selected but are anticipated to be locally available.

The acceptability of Alternative 6 would be affected by the administrative requirements for transport and disposal. The DOT regulates the transport of waste materials. Additionally, local engineering departments would be consulted to evaluate truck traffic impacts on the roads leading to the RVAAP.

7.2.6.7 Cost

The present value cost to complete Alternative 6 is approximately $3,958,169(in base year 2005 dollars with a 3.1% discount factor). Implementing the removal, disposal, treatment, and subsequent confirmation sampling are included in this cost. See Appendix 7 for a detailed description of Alternative 6 costs.

7.2.7 Comparative Analysis of Load Line 12 Alternatives Using National Contingency Plan Criteria

In this section, a comparative analysis of the six remedial alternatives applicable to Load Line 12 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.

Six remedial alternatives were retained for Load Line 12:

- Alternative 1: No Action (i.e., no remedial actions conducted onsite);
- Alternative 2: Limited Action (e.g., as preparation of master planning documents, land use controls, 5-year reviews);
- Alternative 3: Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use;
- Alternative 4: Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use;
- Alternative 5: Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use; and
- Alternative 6: Excavation of Soils/Dry Sediments, Treatment, 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.

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

Each of the alternatives except Alternative 1 is protective of human health and the environment for the National Guard Trainee, Trespasser, and Subsistence Residence Farmer. The degree of protection and the permanence of an alternative is a function of the extent contaminant removal or land use control strategies are used. The potential future human health HIs are also below the target level of 1 for non-carcinogenic compounds. Alternative 1 is not protective of human health for the residential land use scenario. The HHRA for Load Line 12 indicates potential future human health risks could exceed the target risk of 1E-05 and are at the upper bound of the CERCLA acceptable range of 1E-06 to 1E-04 under the restricted (represented by the National Guard Trainee) and (represented by a Resident Subsistence Farmer) residential land use scenarios.

Alternative 2 is protective of human health and the environment assuming instituted land use controls will be adequately implemented and maintained. It is assumed also that personnel onsite will be properly trained for OHARNG future land use.

Alternatives 3 and 5 are protective by removing impacted dry sediment above risk goals to accomplish National Guard Trainee land use. Subsequent to contaminant removal, land use controls will be implemented to restrict access to the AOC. Alternatives 4 and 6 also are protective remediating impacted dry sediment to residential land use preliminary cleanup goals.

7.2.7.2 Compliance with ARARs

Potential ARARs for remediation of soils/dry sediments at Load Line 12 are presented in Chapter 4. Each alternative could be designed and implemented to meet respective ARARs.

7.2.7.3 Long-Term Effectiveness and Permanence

Alternative 1 includes no long-term management measures to prevent exposures to or the spread of contamination and is, therefore, rated low. Implementing land use controls as represented in Alternative 2 is considered moderately effective and permanent since such controls can potentially fail.

The long-term effectiveness and permanence of Alternatives 3 and 5 is considered high. These alternatives are permanent and effective since AOC contamination is removed and National Guard Trainee land use standards are achieved.

The long-term effectiveness and permanence of Alternatives 4 and 6 is also considered high. These alternatives are highly permanent and effective since impacted soils and dry sediment are removed to residential land use preliminary cleanup goals.

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

The ability of Alternatives 1 through 4 to reduce contaminant volume, toxicity, and mobility is low since these alternatives do not involve treatment. In contrast, a major component of Alternatives 5 and 6 is treatment of excavated impacted soil/sediment and therefore is considered effective in contaminant mobility reduction. Since the treatments proposed in Alternatives 5 and 6 may increase waste volumes and likely will not affect contaminant toxicity, the alternatives are rated overall as medium.

7.2.7.5 Short-Term Effectiveness

Alternatives 1 and 2 have no short-term risks to the community beyond baseline conditions and are, therefore, rated high. The short-term effectiveness for Alternatives 3 and 4 are affected by the potential excavation and transportation of impacted soils/dry sediment. These alternatives may expose the workers to impacted soils/dry sediment, although mitigation measures would be anticipated to reduce or eliminate these risks. Consequently, Alternatives 3 and 4 are assigned a medium rating.

Alternatives 5 and 6 have the same elements as Alternatives 3 and 4 with the addition of treating impacted soils/dry sediments. The subsequent potential exposure of workers to treatment chemicals and additional waste handling necessary to accomplish treatment render Alternatives 5 and 6 low ratings.

7.2.7.6 Implementability

All action alternatives are considered implementable on a technical and availability-of-services basis. Alternative 1 is a No Action alternative and rated high in terms of implementability. Alternative 2 involves the use of land use controls at the AOC. Currently, RVAAP has facility-wide and Load Line 12-specific access restrictions being enforced. Accordingly, implementing AOC specific land use controls should not be difficult and the alternative is consequently rated high. Alternatives 3 and 4 should be readily implementable since conventional construction operations are involved. However, these activities are considered more complex than Alternatives 1 and 2. Thus Alternatives 3 and 4 are rated medium.

Alternatives 5 and 6 should be moderately easy to implement since S/S treatment technologies are well established. Alternative 6 will be more difficult to implement due to the relative large amounts of soil/sediment requiring treatment. Therefore, Alternative 5 is rated medium and Alternative 6 is rated low.

7.2.7.7 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:

Alternative 1:	$	0
Alternative 2:	$	209,194
Alternative 3:	$	364,789
Alternative 4:	$	1,794,453
Alternative 5:	$	655,064
Alternative 6:	$	3,958,169

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for Load Line 12

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use	Alternative 5 Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 6 Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use
1. Overall Protectiveness						
Human Health Protection	Not protective for anticipated OHARNG future land use (National Guard Trainee). Not protective for residential land use	Protective for soil, may not be protective for sediment at the Main Ditch under anticipated OHARNG future land use (National Guard Trainee). Not applicable for residential land use	Protective due to removal of impacted media and institution of land use controls	Protective due to removal of impacted media	Protective due to removal of impacted media and institution of land use controls	Protective due to removal of impacted media
Environmental Protection	No mitigation of calculated risks to ecological receptors; however, ecological risks are not likely to be high	No mitigation of calculated risks to ecological receptors; however, ecological risks are not likely to be high	The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC	The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC	The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC	The remedial actions taken to protect human health also will reduce risks to ecological receptors that occupy or visit this AOC
2. Compliance with ARARs						
ARARs	Compliant. No chemical- or location-specific ARARs identified	Compliant. No chemical- or location-specific ARARs identified	Compliant. No chemical- or location-specific ARARs identified. ARARs only apply if action is taken	Compliant. No chemical- or location-specific ARARs identified. ARARs only apply if action is taken	Compliant. No chemical- or location-specific ARARs identified. ARARs only apply if action is taken	Compliant. No chemical- or location- specific ARARs identified. ARARs only apply if action is taken

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for Load Line 12 (continued)

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use	Alternative 5 Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 6 Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use
3. Long-Term Effectiveness and Permanence						
Magnitude of Residual Risk	Residual risk/ hazard exceeds target risk/hazard for restricted and residential land use	Residual risk/ hazard exceeds target risk/hazard for restricted and residential land use	Residual risk/ hazard exceeds target risk/hazard for residential land use	Residual risk/ hazard below target	Residual risk/ hazard exceeds target risk/hazard for residential land use	Residual risk/ hazard below target
Adequacy and Reliability of Controls	No land use controls	Land use controls adequate and reliable	Land use controls adequate and reliable	No land use controls required	Land use controls adequate and reliable	No land use controls required
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.	Required since soils would remain onsite in exceedance of residential land-use cleanup goals	No long-term management required as residential land use achieved.
4. Reduction of Toxicity, Mobility, or Volume through Treatment						
Reduction through Treatment	None (no treatment)	None (no treatment)	None (no treatment)	None (no treatment)	Mobility reduction for stabilization	Mobility reduction for stabilization

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for Load Line 12 (continued)

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Resident Subsistence Farmer Land Use	Alternative 5 Excavation of Soils/ Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 6 Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use
5. Short-Term Effectiveness						
Community	No immediate risk to community	No immediate risk to community	Slight risk due to construction and transportation activities. Controlled by mitigating measures	Slight increase in risk due to construction and transportation activities. Controlled by mitigating measures	Increase in risk due to construction, treatment, and transportation activities. Controlled by mitigating measures	Increase in risk due to construction, treatment, and transportation activities. Controlled by mitigating measures
Workers	No activities to take place, therefore no risk to workers	Minimal risk to workers	Workers may be exposed to impacted soils/sediment and heavy equipment hazards. Safety measures would mitigate risk	Workers may be exposed to impacted soils/sediment and heavy equipment hazards. Safety measures would mitigate risk	Workers may be exposed to impacted soils/sediment, chemicals required for soil treatment, and heavy equipment hazards. Safety measures would mitigate risk	Workers may be exposed to impacted soils/sediment, chemicals required for soil treatment, and heavy equipment hazards. Safety measures would mitigate risk
Ecological Resources	No ecological impacts beyond existing conditions	No ecological impacts beyond existing conditions	Excavation would result in a temporary loss of vegetated habitat. Potential short term environmental impacts minimized by engineering controls	Excavation would result in a temporary loss of vegetated habitat. Potential short term environmental impacts minimized by engineering controls	Excavation would result in a temporary loss of vegetated habitat. Potential short term environmental impacts minimized by engineering controls	Excavation would result in a temporary loss of vegetated habitat. Potential short term environmental impacts minimized by engineering controls

Table 7-1. Summary of Detailed Analysis of Remedial Alternatives for Load Line 12 (continued)

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/ Dry Sediment and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediment and Offsite Disposal ~ Resident Subsistence Farmer Land Use	Alternative 5 Excavation of Soils/Dry Sediment, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 6 Excavation of Soils/Dry Sediment, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use
Engineering Controls	None	None	Potential releases controlled with management and engineering practices	Potential releases controlled with management and engineering practices	Potential releases controlled with management and engineering practices	Potential releases controlled with management and engineering practices
Tome to Complete[a]	0 years	0 years	1 months	2 months	2 months	3 months
O&M Period	0 years	30 years (estimated)	30 years (estimated)	0 years	30 years (estimated)	0 years
6. Implementability						
Technical Feasibility	Not applicable	Feasible	Feasible	Feasible	Moderately feasible, depending upon effectiveness of treatment techniques	Moderately feasible, depending upon effectiveness of treatment techniques
Administrative Feasibility	Not applicable	Relatively easy. Access restrictions already in place at Load Line 12	Relatively easy	Relatively easy	Relatively easy	Relatively easy
Cost						
Estimated Cost[b]	$0	$209,194	$364,789	$1,794,453	$655,064	$3,958,169

[a]Time to complete remedial action after completion of remedial design, assuming timely project funding. Does not include O&M period.
[b]Estimated costs calculated as net present value in base year 2005 dollars using a 3.1% discount factor.

Table 7-2. Summary of Comparative Analysis of Remedial Alternatives for Load Line 12

NCP Evaluation Criteria	Alternative 1 No Action	Alternative 2 Limited Action	Alternative 3 Excavation of Soils/Dry Sediments and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 4 Excavation of Soils/Dry Sediments and Offsite Disposal ~ Unrestricted Land Use	Alternative 5 Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use	Alternative 6 Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Unrestricted Land Use
1. Overall Protectiveness	Not protective	Protective	Protective	Protective	Protective	Protective
2. Compliance with ARARs	Compliant	Compliant	Compliant	Compliant	Compliant	Compliant
3. Long-Term Effectiveness and Permanence	Low	Medium	High	High	High	High
4. Reduction of Toxicity, Mobility, or Volume through Treatment	Low	Low	Low	Low	Medium	Medium
5. Short-Term Effectiveness	High	High	Medium	Medium	Low	Low
6. Implementability	High	High	Medium	Medium	Medium	Low
7. Cost	High	Medium	Medium	Low	Low	Low
	$0	$209,194	$364,789	$1,914,449	$655,064	$4,078,165

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 Load Line 12. 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 AOCs 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 Load Line 12, 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 Load Line 12, meets the needs of the state of Ohio and fulfills the requirements of the DFFO (Ohio EPA 2004). 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 Load Line 12.

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 U.S. 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 Load Line 12, including the previously completed RI Report and this FS Report.

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 can be viewed 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 Load Line 12 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 Load Line 12. 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 Load Line 12 using data collected during previous investigations. This FS examined the history of Load Line 12 and previous investigations, developed media-specific preliminary cleanup goals and RAOs for the AOC, and screened a range of technologies potentially applicable for meeting these objectives.

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 (National Guard Trainee) for likely future land use by OHARNG. The preliminary cleanup goals for the representative receptor 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 National Guard Trainee are also protective of a hunter or a security guard). The potential for the representative receptor to be protective of a trespasser also is addressed. In addition to the National Guard Trainee, 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. Load Line 12 will be transferred to OHARNG and the suspected presence of MEC will be addressed in a subsequent investigation under the MMRP. The suspected presence of MEC requires access restrictions until the MMRP is complete when a final evaluation of the need for land use controls will be made.

The FS establishes RAO and evaluates a range of remedial actions to reduce risks to the environment to obtain remedy for (or cleanup of) Load Line 12 with respect to soils/dry sediments. The RAO analysis identified COCs in impacted soils/dry sediments at Load Line 12 requiring further evaluation of potential remedial alternatives for a residential land use scenario. The RAO analysis indicated current National Guard Trainee 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 with Offsite Disposal ~ National Guard Trainee Land Use;
- Alternative 4: Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer Land Use;
- Alternative 5: Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee Land Use; and
- Alternative 6: Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer Land Use.

These alternatives were assessed and compared against one another to provide information of sufficient quality and quantity to justify the selection of a remedy.

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 Load Line 12.

The ROD will document the final remedy for Load Line 12. Comments on the PP received from state and federal agencies and the public will be considered in drafting the ROD for Load Line 12. 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 Load Line 12 is Alternative 3 (Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee Land Use). This alternative involves the removal of dry sediment in the Main Ditch at Load Line 12 that exceeds preliminary cleanup goals for the National Guard Trainee. This alternative is protective for the anticipated future land use (National Guard Trainee), is cost effective (estimated $364,789 for removal), and can be performed in a timely manner. Following the removal, land use controls and 5-year reviews will be necessary to restrict access to Load Line 12. Access restrictions are already being implemented at Load Line 12 and reinforcement of these controls will bolster the protectiveness of Alternative 3.

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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 Load Line 12 was conducted to evaluate their potential to impact groundwater both at the area of concern (AOC) (residential land use exposure scenario) and at an exposure point downgradient of the AOC (National Guard Trainee 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 National Guard Trainee 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 Remedial Investigation (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 Load Line 12. 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 contaminant migration constituents of potential concern (CMCOPCs). Potential impacts beneath the source were determined from model predictions of observed soil sample results where the predicted concentration at the water table beneath the source exceeded the maximum contaminant level (MCL) or Region 9 Residential preliminary remediation goal (PRG). Constituents also are identified as CMCOPCs if they were detected in AOC groundwater and exceeded the MCL or Region 9 Residential PRG.

The RI Report identified constituents with potential groundwater impacts at receptor locations downgradient of the source area as contaminant migration chemicals of concern. 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 Area of Concern-Specific Evaluation

The constituents identified in Table 3A-1 are evaluated across multiple media. The evaluation examines characteristics of the constituents detected distribution in soil or water compared to background concentrations and 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 each of the AOCs.

Background: If model input source concentrations are less than either surface or subsurface background, predicted results are compared to observed groundwater data. For example, chromium in soils at Load Line 12 source areas were at or below background, yet predicted impacts to groundwater beneath the AOC were in excess of observed groundwater data by factors consistently greater than 100. 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 risk-based concentration (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 Load Line 12

Load Line 12 RI data were grouped (aggregated) for evaluation of contaminant nature and extent by environmental media (soil, sediment, surface water, and groundwater) and by geography. The data were further divided by functional area. For surface [0-1 ft below ground surface (BGS)] and subsurface (1 to 7 ft BGS) soil, the geographic area of Load Line 12 was separated into the Eastern Soil Aggregate and Western Soil Aggregate:

- The Eastern Soil Aggregate encompasses an area of approximately 9 ha (22 acres) east of the principal drainage ditch that bisects the AOC and north of the water tower [see Figure 2-10 in this Feasibility Study (FS) Report].

- The Western Soil Aggregate, consisting of about 23.5 ha (58 acres), includes all former production and support areas within Load Line 12, as well as the Team Track Area. Further subdivision of the Western Soil Aggregate was deemed necessary in the RI. Therefore, the Western Soil Aggregate is subdivided into Building 904, Building 905, Building FF19, and the Team Track Area.

Based on the results of the Phase II RI for Load Line 12 constituents are evaluated for potential impacts in groundwater beneath the source and potential for impacts to groundwater at downgradient receptors. Table 3A-1 summarizes these constituents by the aggregate and functional areas. Further analysis of these constituents with regard to impacts to groundwater is summarized below.

Table 3A-1. Potential Groundwater Impacts Identified in Phase II RI Report for LL12

Potential Groundwater Impact Beneath the Source a	Potential Groundwater Impact Downgradient of the Source b
LL12 - Eastern Soil	
Chromium Nickel	
LL12 - Western Soil - Building 904	
Antimony Chromium (total) Manganese 1,3-Dinitrobenzene 2,4-Dinitrotoluene 2,6-Dinitrotoluene 4-Nitrotoluene RDX	RDX

Table 3A-1. Potential Groundwater Impacts Identified in Phase II RI Report for LL12 (continued)

Potential Groundwater Impact Beneath the Source a	Potential Groundwater Impact Downgradient of the Source b
LL12 - Western Soil - Building 905	
Barium Chromium (total) 1,3-Dinitrobenzene 2,4-Dinitrotoluene RDX	RDX
LL12 - Western Soil - Building FF-19	
Antimony Chromium (total) Manganese Beta-BHC	Antimony Chromium (total) Manganese Beta-BHC
LL12 - Western Soil - Team Track Area	
Antimony Chromium Manganese Nickel 3-Nitrotoluene 4-Nitrotoluene Nitrobenzene Beta-BHC	Manganese

[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.

LL12 – Eastern Soil

- Chromium (total) and nickel are removed from further consideration of future groundwater impacts at LL12-Eastern Soil because all soil concentrations are below subsurface soil background.

LL12 – Western Soil – Building 904

- Antimony, chromium (total), and manganese are removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Building 904 because all soil concentrations are below subsurface soil background.

- 1,3-Dintrobenzene (DNB) and 2,4-Dinitrotoluene (DNT) are removed from further consideration of future groundwater impacts at Load Line 12 Western Soil – Building 904 because soil concentrations are all non-detects.

- 2,6-DNT: RI Seasonal Soil Compartment Model (SESOIL) source load modeling predicted maximum impact in 5 years. Given AOC history, the maximum impact likely occurred in the past. 2,6-DNT is removed from further consideration of future groundwater impacts Load Line 12 because there are few detections in soils, the predicted time of maximum impact to groundwater is 5 years (so maximum impact has likely passed), and 2,6-DNT has not been detected in surface water or groundwater.

- Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX): RI SESOIL source load modeling predicted maximum impact in 4 years. Given AOC history, the maximum impact likely occurred in the past. RDX is removed from further consideration of future groundwater impacts at Load Line 12 because there are few detections in soils, the predicted time of maximum impact to groundwater is 4 years (so maximum impact has likely passed), and RDX has not been detected in the nearest monitoring wells (L12mw-153 and L12mw-154).

LL12 – Western Soil – Building 905

- Barium is removed from further consideration of future groundwater impacts at Load Line 12 – Western Soils – Building 905 because the RI modeling included conservative assumptions (constant source and no degredation/attenuation of contamination), which overestimate groundwater impacts by a factor of 7; the maximum predicted impact is 2.48 mg/L compared to the MCL of 2.0 mg/L; and because no groundwater results currently exceed the MCL at Load Line 12.

- Chromium (total), 1,3-DNB, 2,4-DNT, and RDX are removed from further consideration of future groundwater impacts at LL12 – Western Soil – Building 905 because all soil concentrations are below subsurface soil background.

LL12 – Western Soil – Building FF19

- Antimony is detected in 38 of 54 soil samples and 30 of 38 detected results exceed background (1.0 mg/kg). The maximum surface/subsurface soil result is 79.4 mg/kg and occurs at station L12-081. Antimony was not detected in groundwater at nearby monitoring well L12mw-185. There were no detections in groundwater downgradient of Building FF19 through 2004. Antimony is retained for further consideration of future impacts to groundwater because antimony was widely detected in soils above background and was predicted to produce groundwater impacts beneath LL12 Western Soil – Building FF19 and at downgradient receptor locations.

- Chromium (total) is removed from further consideration of future groundwater impacts beneath Load Line 12 – Western Soil – Building FF19 because both observed concentrations in soils and the source concentration are significantly less than 76 times background. The modeling completed in the RI over-predicts chromium impacts to groundwater because conservative assumptions (constant source and no degradation/attenuation of contamination) were incorporated into the model. Background concentrations produce predicted results that exceed actual observed results by factors ranging from 76 to 393.

- Manganese is removed from further consideration of future groundwater impacts because there is only a single exceedance of background; both the source concentration and the exposure point concentration (EPC) are less than subsurface soil background; and observed groundwater results are similar to background.

- Beta-benzene hexachloride (BHC) is removed from further consideration of future groundwater impacts because the single soil detection (LL12-059) at Building FF19 does not result in predicted impacts to groundwater beneath the AOC and beta-BHC is not detected in groundwater sampled at nearby monitoring well L12mw-185.

LL12 – Western Soil – Team Track Area

- Antimony is detected in 8 of 8 soil samples. The maximum surface/subsurface soil result is 70.3 mg/kg at station L12-235. The soil EPC (5.0 mg/kg) also exceeds background (1.0 mg/kg). Antimony was not detected in groundwater at Load Line 12 through 2004. Antimony is retained for further consideration of future impacts to groundwater because antimony was widely detected in soils above background and was predicted to produce groundwater impacts beneath Load Line 12 – Western Soil – Team Track Area and at downgradient receptor locations.

- Chromium (total) is removed from further consideration of future groundwater impacts at the Load Line 12 – Western Soil – Team Track Area because all soil concentrations are below subsurface soil background.

- Manganese and nickel are removed from further consideration of future groundwater impacts at Load Lien 12 – Western Soil – Team Track Area because all soil concentrations are below subsurface soil background.

- 3-Nitrotoluene: RI SESOIL source load modeling predicted maximum impact in 2 years. Given the AOC history, the maximum impact likely occurred in the past. 3-Nitrotoluene is removed from further consideration of future groundwater impacts at the Load Line 12 – Western Soil – Team Track area because soil detections are at low levels, the predicted time of maximum impact to groundwater is 2 years (so maximum impact has likely passed), and 3-nitrotoluene has only been detected in groundwater below the groundwater Region 9 residential PRG.

- 4-Nitrotoluene is removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Team Track Area because soil concentrations are all non-detects.

- Nitrobenzene: RI SESOIL source load modeling predicted maximum impact in 3 years. Given AOC history, the maximum impact likely occurred in the past. Nitrobenzene is removed from further consideration of future groundwater impacts at Load Line 12 – Western Soil – Team Track area because there is only a single detection; the predicted time of maximum impact to groundwater is 3 years (so maximum impact has likely passed), and nitrobenzene has only been detected in groundwater below the groundwater Region 9 residential PRG.

3A.2.3 Refined AOC-Specific Modeling Results

Based on analyses of the fate and transport (F&T) assessment performed in support of the RI for Load Line 12 (detailed in Section 3A.2.2 above), the following constituents of concern (COCs) were identified for further analysis using the SESOIL/ Analytical Transient 1, 2, 3-Dimensional (AT123D) models previously developed with refined input parameters:

- Antimony in soils at LL12 – Western Soils – Building FF19, and
- Antimony in soils at LL12 – Western Soils – Team Track Area.

Source areas, source area concentrations, and distances to potential receptors were updated for this refined analysis. Inherent limitations and assumptions of F&T modeling with SESOIL and AT123D are discussed in detail in Section 5.5.2.4 of the Phase II RI for LL12.

At Load Line 12, focusing of the source areas in both functional areas produces increased concentrations in the representative soil profile. However, the main difference between refined modeling and modeling previously reported in the Phase II RI for Load Line 12 is the distance to the receptor. At the refined Building FF-19 source area, the refined distance to the receptor is 875 feet; previously, the distances to receptors were 200 ft (to the AOC boundary) and 17 ft (to a nearby ditch). At the Team Track Area, the refined distance to the receptor is 150 ft; previously, the distances to receptors were 116 ft (to the AOC boundary) and 25 ft (to a nearby ditch).

The source areas, average depths to the water table, and depths of soil detection for each revised scenario are presented in Table 3A-2. The reasonable maximum exposure values are calculated in 1-ft sampling depth intervals over the vertical extent of detected concentrations and used as initial concentrations in SESOIL modeling. As explained in Section 5.5.2 of the Phase II RI for Load Line 12, the SESOIL model defines the soil compartment as a soil column extending from the ground surface through the unsaturated zone to the upper level of the saturated soil zone (water table). Most hydrogeologic parameters used in refined SESOIL and AT123D modeling are the same as those presented in Table 5-2 of the Phase II RI for Load Line 12. Refinement of the source areas, however, requires recalibration of the recharge assigned in SESOIL; Table 3A-3 presents these updated parameters. The refined initial concentrations required for SESOIL modeling are presented in Table 3A-4.

Table 3A-2. Refined Fate and Transport Scenarios

Scenario	Area	Average Depth to Water Table	Depth of Soil Detections	Distance to Receptor
LL12 - Antimony FF19 - Refined Source	29,712 ft2	10.93 ft	5 ft	AOC Boundary: 875 ft
LL12 - Antimony Team Track Area - Refined Source	40,000 ft2	3.43 ft	3 ft	AOC Boundary: 150 ft

AOC = Area of concern.

Table 3A-3. Refined Fate and Transport Recharge Properties for SESOIL

Scenario	Intrinsic Permeability (cm2)	Disonnectedness Index
LL12 - Antimony FF19 - Refined Source	0.16E-09	10
LL12 - Antimony Team Track Area - Refined Source	0.20E-09	11

SESOIL = Seasonal Soil Compartment (model).

Table 3A-4. SESOIL Initial Concentrations for Refined Fate and Transport Models

Scenario	Layer	Layer Thickness	Sublayer	Sublayer Depth	Concentration (mg/kg)	Layer Purpose
Antimony at LL12 - FF19						
LL12 Antimony FF19 Refined Source (Area=29,712 ft2)	1	5 ft	1	1 ft	43.06	Source Loading
			2	2 ft	5.59	
			3	3 ft	5.91	
			4	4 ft	2.1	
			5	5 ft	0.78	
	2	5 ft	1	6 ft	0.0	Leaching
			2	7 ft	0.0	
			3	8 ft	0.0	
			4	9 ft	0.0	
			5	10 ft	0.0	
	3	1 ft	1	10.5 ft	0.0	Leachate Determination
			2	11 ft	0.0	
			Sublayer	Sublayer Depth	Concentration (mg/kg)	
Antimony at LL12 - Team Track Area						
LL12 Antimony Team Track Area Refined Source (Area=40,000 ft2)	1	2 ft	1	1 ft	70.3	Source Loading
			2	2 ft	1.6	
	2	1 ft	1	2.25 ft	1.6	Source Loading
			2	2.5 ft	1.6	
			3	2.75 ft	1.6	
			4	3 ft	1.6	
	3	0.4 ft	1	3.1 ft	0.0	Leaching and Leachate Determination
			2	3.2 ft	0.0	
			3	3.3 ft	0.0	
			4	3.4 ft	0.0	
			2	7 ft	0.0	
			Sublayer	Sublayer Depth	Concentration (mg/kg)	

SESOIL = Seasonal Soil Compartment (model).

The results of refined F&T modeling are presented in Table 3A-5. Antimony at Load Line 12 is predicted to exceed the MCL in groundwater beneath the refined Building FF19 source area and refined Team Track Area source area. Based on refined modeling with AT123D, antimony is not predicted to exceed the MCL at receptors downgradient of Building FF19 or the Team Track Area.

Table 3A-5. Refined Fate and Transport Modeling Results

Scenario	SESOIL-Predicted Cleachate,max at Source Water Table (mg/L)	Predicted Tmax (years)	Predicted Cgw,max at Sourcea (mg/L)	Predicted Cgw,max at Receptora (mg/L)	MCL (mg/L)	Exceedance at Exposure Point
LL12 - Antimony FF19 - Refined Source	3.17E-01	807	2.04E-01	0	6.00E-03	No
LL12 - Antimony Team Track Area Refined Source	8.29E-01	274	3.96E-01	4.76E-03	6.00E-03	No

[a]The predicted maximum concentration in groundwater Cgw,max is calculated using the AT123D model based on contaminant loading predicted by SESOIL.
MCL = Maximum contaminant level.
SESOIL = Seasonal Soil Compartment (model).

3A.3 CONCLUSIONS

Groundwater impacts in excess of MCLs are predicted for impacted soils at Load Line 12 as noted below:

- Antimony in soils at LL12 – Western Soils – Building FF19; and
- Antimony in soils at LL12 – Western Soils – Team Track Area.

The predicted impacts in groundwater beneath Load Line 12 of these COCs are not predicted to reach downgradient receptor locations. Therefore, soil remediation for protection of groundwater would be required for antimony in soils at Load Line 12 with respect to residential land use.

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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/dry sediments at Load Line 12 for preliminary cleanup goals based on the National Guard Trainee and Resident Subsistence Farmer land use exposure scenario. The volume of impacted soils and dry sediments is driven by the constituents of concern (COCs) and preliminary cleanup goals identified in Chapter 3 of this Feasibility Study (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 Load Line 12. Table 3B.1 summarizes the COCs and preliminary cleanup goals modeled to generate estimated volumes of impacted soils/dry sediments at Load Line 12 where COCs in these media were identified to be evaluated further in the FS.

The predominant source of data for developing the volume estimates at Load Line 12 was the Remedial Investigation (RI) Report. Analytical data from these investigations defined the nature and extent of contamination at this area of concern (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 Goal (mg/kg)
Load Line 12 ~ National Guard Trainee Land Use			
Sediment	Arsenic	408	31
Load Line 12 ~ Resident Subsistence Farmer Land Use			
Soil	2,4,6-Trinitrotoluene (Western Aggregate)	165	32
	Benzo(a)pyrene (Western Aggregate)	2.5(s), 1.1(sub)	0.59
	Dibenz(a,h)anthracene (Western Aggregate)	0.77(s), 0.42(sub)	0.59
Sediment	Silver (Active Area Channel)	397	370
	Arsenic (Main Ditch)	408	20
	PCB-1016 (Main Ditch)	2.8	1.2
	PCB-1254 (Main Ditch)	11	1.2

COC = Constituent of concern.
EPC = Exposure point concentration.
PCB = Polychlorinated biphenyl.
(s) = shallow surface soil (0-1 ft bgs) EPC (sub) = subsurface soil (1-3 ft bgs) EPC

3B.3 MODELING

Environmental data (i.e., analytical data) were used to develop three-dimensional (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 two-dimensional contouring programs into three dimensions. The environmental data at Load Line 12 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 site knowledge is incorporated into the model to permit a more accurate representation of contaminant extent and volume estimates. Pertinent site 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 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 at each of the AOCs:

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

- Site knowledge (reported or observed) pertaining to the extent of the ditches, etc. permits an accurate representation of these features in the 3D 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 yds^3after excavation or ex situ.

3B.3.1.1 Historical Information and Site Knowledge

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 Over-excavation and Constructability

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 of. 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

The estimated soil/dry sediment volumes developed for Load Line 12, as described in Section 3B.3, are summarized below and in Table 3B.2.

3B.4.1 Load Line 12 ~ National Guard Trainee Land Use

For the National Guard Trainee land use scenario at Load Line 12, arsenic in sediment at the Main Ditch is the only COC with exceedances above the preliminary cleanup goals. Four sediment samples exceeded the preliminary cleanup goal in the Main Ditch. The modeled extent of the contamination in the ditch resulted in an estimated 968 yds^3 (in situ) of impacted sediment (Figure 3B-1).

3B.4.2 Load Line 12 ~ Resident Subsistence Farmer Land Use

For the Resident Subsistence Farmer land use scenario at Load Line 12, both soil and sediment exceeded preliminary cleanup goals (Figure 3B-2). Much of the impacted areas are not localized, rather the modeled extent is driven by isolated exceedances with the exception of the Main Ditch. Exceedances in the upgradient location (L12-228) are not included in the modeled extent. Impacts at this location are attributed to the upgradient Atlas Scrap Yard or the roadway at the western AOC boundary in the Phase II RI Report (USACE 2004a). Soils (removed to depth of 1 ft) near former Building FF19 and the Team Track Area are modeled to address potential impacts to groundwater from antimony in soils, as detailed in the fate and transport (F&T) assessment (Appendix 3A). Figure 3B-2 depicts the modeled extent for the Resident Subsistence Farmer land use resulting in an estimated 15,164 yds^3 (in situ) of impacted soils/dry sediments.

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

Site/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)
Load Line 12 National Guard Trainee Land Use – Sediment*	10,600	20,900	774	26,125	968	31,350	1,161
Load Line 12 Resident Subsistence Farmer Land Use – Sediment*	11,706	21,453	794	26,816	993	32,180	1,191
Load Line 12 Resident Subsistence Farmer Land Use – Soil	103,372	198,168	11,337	247,710	14,171	297,252	17,006

*volumes are calculated based on sediment removal varying from 0.5 to 2.0 feet in depth

[a] Includes 25% constructability factor

[b] Includes 20% swell factor

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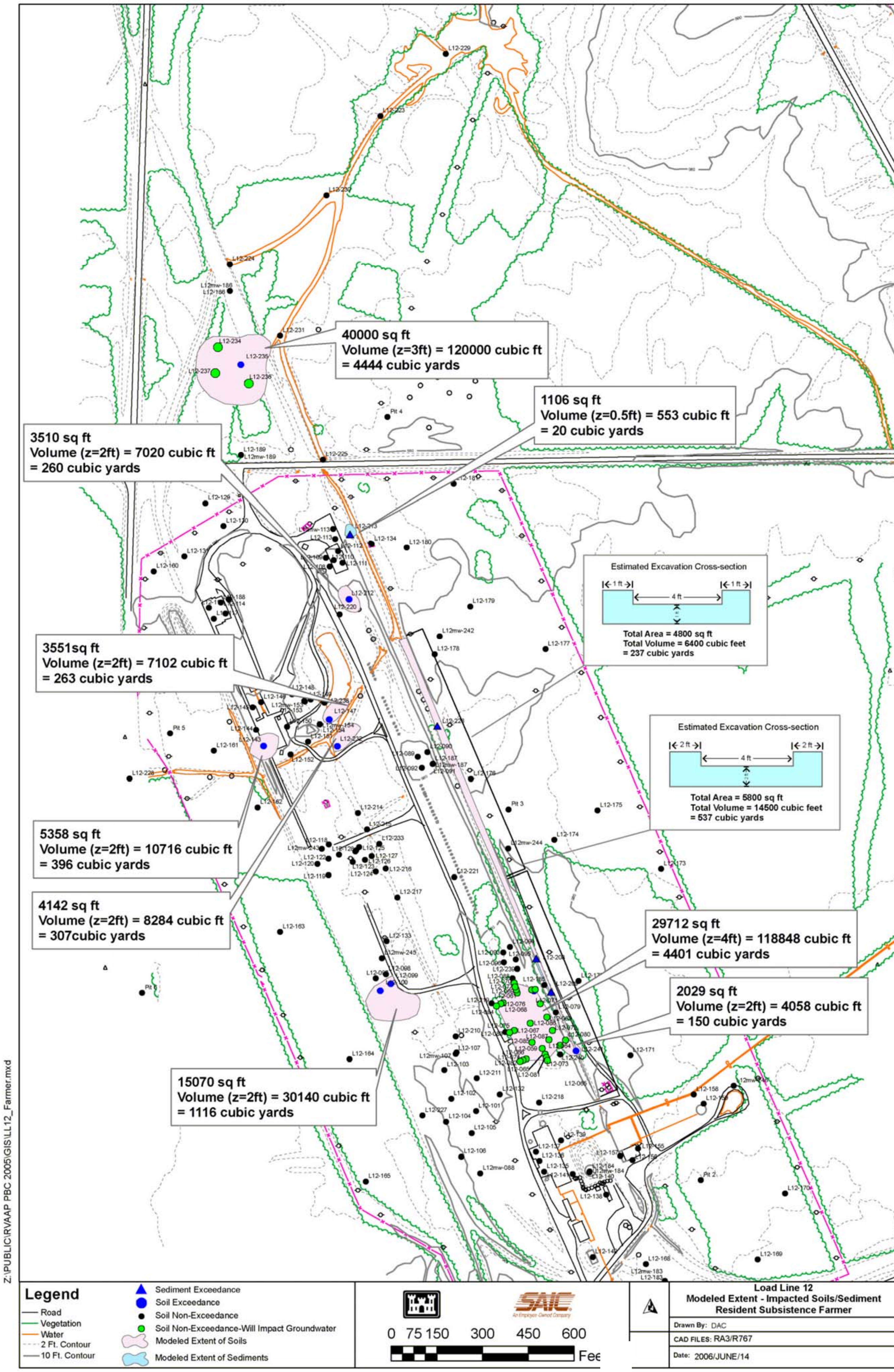

Figure 3B-1. Modeled Extent at Load Line 12 – National Guard Trainee Land Use

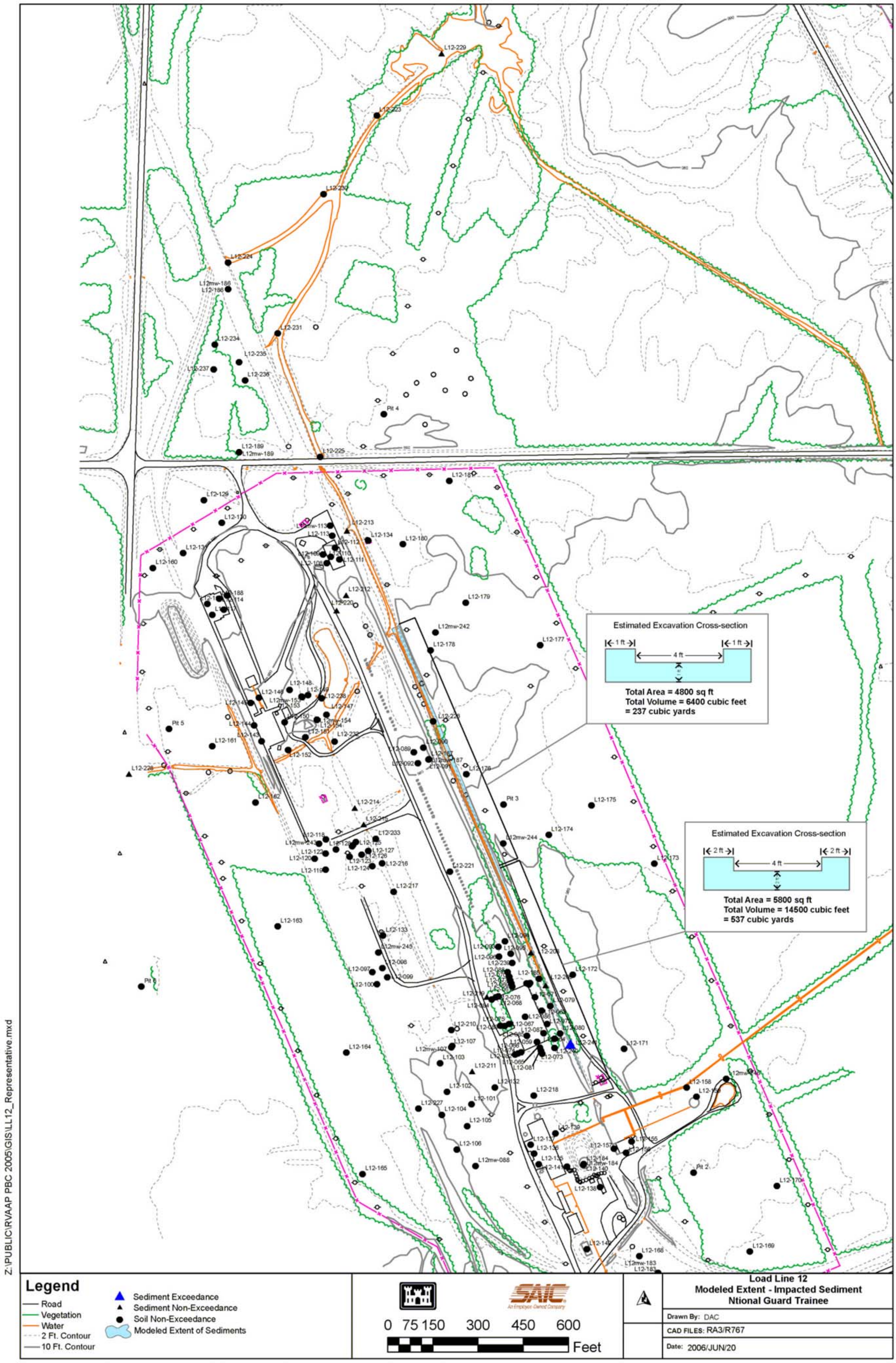

Figure 3B-2. Modeled Extent at Load Line 12 – Resident Subsistence Farmer Land Use

Appendix 5
Initial Screening of
Technologies ~ Aqueous Media

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5.0 TECHNOLOGY TYPES AND PROCESS OPTIONS ~ AQUEOUS MEDIA

This section describes the identification and screening of technology types and process options for constituents of concern (COCs) in impacted aqueous media at Load Line 12 (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. These steps include:

- Identifying general classes of response actions, or GRAs, suitable for Load Line 12 (Section 5.1).
- Identifying technologies and process options applicable to the GRAs and performing an initial screening for aqueous media (Section 5.2).

The FRTR has provided guidance for the evaluation of remedial technologies. FRTR provides a screening matrix which 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 Load Line 12. GRAs are actions that will satisfy the remedial action objectives (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 not presented in this Feasibility Study (FS); however, GRAs were selected based on the media of concern (wet sediment, surface water and groundwater). 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, controls, or monitoring would be discontinued. This action complies with the Comprehensive Environmental Response, Compensation, and Liability Act (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 Load Line 12 include measures that will restrict land use changes over the long-term, such as governmental controls and enforcement tools. Governmental controls could include building restrictions and zoning controls, while enforcement tools may involve administrative orders, consent decrees or proprietary measures such as negative easements. Informational devices can be governmental (i.e., such as handing out information as part of a permit process) or proprietary (i.e., entering a notice on a deed) and are more short-term than governmental controls. 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 *Code of Federal Regulations* § 300.430(a)(1)(iii)(D)].

If land use controls are selected as a component of a remedial alternative achieving restricted 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 unlimited use and unrestricted release.

5.1.3 Containment

Containment actions for aqueous media include technologies that protect human health and the environment by physically precluding contact with the impacted media. Containment technologies prevent or alter the natural flow by constructing a low-permeability material barrier (e.g., sheet piles, semi-permeable membrane, slurry walls, jet grouting, soil freezing, and hydraulic barriers) to reduce the migration of COCs and the potential for exposure. For impacted surface water and groundwater, containment would restrict or slow the flow from impacted areas, thereby requiring measures to control inflow into such areas such as the infiltration of surface water. This could be accomplished by surface capping of impacted areas or by removal of groundwater/surface water sources upgradient of the containment barrier.

5.1.4 Removal

Removal of impacted surface water and groundwater would reduce the potential for long-term human exposure. Surface water and groundwater could be removed using conventional pumping (e.g. diaphragm pumps) and extraction well technology (e.g., vertical and/or horizontal wells). Dewatering would minimize direct human contact with impacted material as well as its migration.

5.1.5 Treatment

Physical treatment processes considered for aqueous media include various in situ and ex situ approaches, such as adsorption, air stripping/packed tower, evaporation ponds, crystallization, and permeable treatment walls. Chemical processes use chemical reactions such as flocculation and precipitation treatment processes to remove COCs. Biological treatment such as bioremediation or monitored natural attenuation use microbes to degrade or adsorb aqueous contaminants. Thermal treatment techniques such as steam stripping or supercritical water oxidation uses elevated temperatures to initiate a phase change (e.g., liquid to gas) to remove COCs.

5.1.6 Disposal and Handling

Disposal actions for aqueous media include deep well injection, discharge to surface water, or discharge to a publicly owned treatment works (POTW) or other disposal facility in accordance with required permits. Beneficial reuse (e.g., land spraying/irrigation, reclamation/recycle/reuse) also will be considered for the discharge of groundwater. Transport could be accomplished using various modes of transportation. Truck, railcar, and/or barge transport could be used to ship waste materials onsite or offsite.

5.2 INITIAL SCREENING OF TECHNOLOGIES ~ AQUEOUS MEDIA

This section describes the identification and initial screening of potential technologies to achieve RAOs for aqueous media (i.e., groundwater and surface water) at Load Line 12 (as summarized in Section 3.6). Technology types and process options were selected on the basis of their applicability to the environmental media of interest (e.g., surface water). Process options were either retained or eliminated from further consideration on the basis of technical implementability and effectiveness against listed COCs. For the purposes of this FS, surface water and groundwater technologies are to be initially screened. However, these technologies will not be further developed or researched in the detailed screening of technologies. Results of the initial technology screening are summarized in Table 5-1.

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 controls or technologies 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 include land use controls and 5-year reviews. Land use controls are physical, legal, and administrative 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 legal and administrative mechanisms depends on an entity assuming responsibility for initiating, implementing, and maintaining the controls. The implementability of legal and administrative controls depends upon arrangements made between property owners in different governmental jurisdictions and the authority of local governments. Specific characteristics of the AOC determine which controls are appropriate. Legal impediments and costs also affect implementability and schedules. The National Contingency Plan 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 unrestricted land use require environmental monitoring and 5-year reviews to determine whether the integrity of the controls remains intact. When the AOC achieves a level of contamination that allows for unlimited use and unrestricted exposure, then at that time 5-year reviews may be discontinued.

5.2.3 Containment

Containment technologies for surface water or groundwater prevent or alter the natural groundwater flow through the installation of vertical or horizontal barriers, or injection into a hydraulically isolated unit through wells, thus preventing the migration of COCs. The technology type considered for Load Line 12 is vertical barriers. Vertical barrier walls would be constructed down to a naturally-occurring horizontal barrier (such as a clay zone or bedrock) that significantly retards vertical contaminant migration in the groundwater.

Contaminated groundwater and/or contaminated surface water and associated soils would be effectively isolated from interaction with uncontaminated groundwater and/or surface water through construction of barriers keyed at the base into relatively impermeable clay or bedrock layers at depth. Process options screened included sheet piles, semi-permeable membranes, slurry walls, jet grouting, soil freezing, and hydraulic barriers. These are susceptible to cracking if not properly maintained. Slurry walls are the most common type of subsurface barrier due to their low cost. These walls are constructed in a vertical trench excavated under a slurry. The slurry acts like a drilling fluid by hydraulically shoring the trench to prevent collapse and forming a filter cake on the trench walls to impede fluid losses into the surrounding ground. Sheet piles are metal barriers which are driven into the ground or lake/stream bed to form an impenetrable boundary. Semi-permeable membranes are normally installed in trenches. These membranes normally allow groundwater to flow through them, while filtering out contaminants and containing plume movement.

Containment is a very effective treatment technology of inorganics and explosives. Containment is retained in the initial screening process for the surface water and groundwater scenarios at Load Line 12.

5.2.4 Removal

Removal of contaminated surface water or groundwater would reduce the potential for long-term human and environmental exposure. Removal would minimize long-term direct human contact with and the local migration of impacted material. Surface water and groundwater could be removed using conventional pumping (e.g. diaphragm pumps) and extraction well technology (e.g., vertical and/or horizontal wells). Dewatering would minimize direct human contact with impacted material as well as its migration.

5.2.4.1 Surface Pumping

The process options evaluated for removal of surface water include using pumps to remove contaminated surface water or sediment from a water body for treatment or disposal. At each location where surface water and wet sediment is considered in a COC, surface pumping can be implemented.

5.2.4.2 Vertical Wells

The process options evaluated for removal of groundwater includes extraction using vertical wells. Vertical wells remove groundwater from aquifers or perched water zones. The implementability of vertical wells is dependent on the properties of the aquifer and well construction factors. If the source contamination is not removed, continual groundwater extraction may be required to ensure long-term effectiveness.

At this stage, it is assumed groundwater removal is possible by the use of vertical wells. Therefore, groundwater removal is retained during the initial screening for Load Line 12.

5.2.4.3 Horizontal Wells

The process options evaluated for removal of groundwater also includes extraction using horizontal wells. Systems utilizing horizontal wells generally require fewer wells than vertical well-based networks because horizontal well screens provide greater surface area contact with contaminated soils and groundwater. Horizontal wells may also be installed using directional drilling techniques, allowing wells to be installed underneath buildings and other structures. The implementability of horizontal wells is dependent on the properties of the aquifer and well construction factors. If the source contamination is not removed, continual groundwater extraction may be required to ensure long-term effectiveness.

At this stage, it is assumed groundwater removal is possible by use of horizontal wells. Therefore, groundwater removal is retained during the initial screening for Load Line 12.

5.2.5 Treatment

Process options screened for the treatment of surface water and groundwater consist of ex situ and in situ processes, including various physical, chemical, biological, and thermal options. Many of these treatments also can be used for treating collected sediment slurry water and will be evaluated accordingly.

5.2.5.1 In Situ Physical/Chemical Treatment

In situ physical/chemical treatment options include air sparging, geochemical immobilization, chelation, directional wells, electrokinetics, hydrofracturing, in-well air stripping, permeable treatment walls, and vacuum extraction/bioslurping.

Air Sparging: Air is introduced to groundwater using wells to volatilize organic contaminants, and is only effective for treatment of volatile organic compounds (VOCs) and therefore is not retained.

Geochemical Immobilization: Geochemical immobilization is an in situ process that involves locally adjusting the pH and reduction-oxidation (redox) conditions. This reduces the solubility and/or changes the speciation of contaminants, largely precipitating them in the saturated zone. This process is effective for the treatment of inorganics COCs which would be effective for surface water and groundwater at Load Line 12.

Chelation: Chelating molecules exhibit a high degree of selectivity for many metals. Chelating agents are used to enhance the in situ solubility or mobility of target constituents. This process is effective for the treatment of inorganic COCs which would be effective for surface water and groundwater at Load Line 12.

Directional Wells (Enhancement): Directional wells are wells installed using drilling techniques horizontally or at an angle to reach contaminated zones unreachable by conventional vertical drilling. This can enhance the utility of other remediation strategies, and is retained as a potential enhancement for contaminated groundwater at Load Line 12.

Electrokinetics: Electrokinetics is an electrochemical process involving electrodes and permeable membranes in which cations (such as metals and hydronium ions) are driven through the saturated zone (or interstitial moisture above the water table) to one or more anodes, while anions are forced to the cathode(s). At the anode, metal contaminants cross a semi-permeable membrane and are extracted on the surface for treatment or disposal. This process is retained for surface water and groundwater at Load Line 12.

Hydrofracturing (Enhancement): Similar to the fracturing enhancement described for soil remediation techniques, hydrofracturing is a pilot level technology that introduces high pressure fluids into a relatively impermeable substrate in order to increase hydraulic conductivity. This is meant to enhance the effectiveness of other remedial technologies, and is retained for all scenarios. This technology is applicable to the groundwater scenarios at Load Line 12, but not surface water.

In-Well Air Stripping: Air is injected into a double-screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, VOCs in the contaminated groundwater are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a SVE system. The partially treated groundwater is forced into the vadose zone, and the process is repeated as water follows a hydraulic circulation pattern or cell that allows continuous cycling of groundwater. As groundwater circulates through the treatment system in situ, contaminant concentrations are gradually reduced. This technology is ineffective for treating inorganics and high explosives, and is not retained.

Permeable Treatment Walls: In this process, treatment walls are emplaced to intercept groundwater. As the impacted water flows through the wall, the contaminants (specifically VOCs, SVOCs, and inorganics) are decomposed or bound as a result of chemical reactions. This option is adaptable to a variety of sites when used in conjunction with funnel and gate systems. Depth of the contaminated groundwater is a major constraint on applicability. This technology is best applied where there is a well-characterized contamination plume and flow gradient. It is retained for groundwater at Load Line 12. This process is not retained as a method of treatment for surface water.

Vacuum Extraction/Bioslurping: This process option involves the use of vacuum pumps to remove contaminants from groundwater. It is used to treat volatile organics, and is ineffective at treating explosives or inorganics, therefore it is not retained.

5.2.5.2 Ex Situ Physical/Chemical Treatment

Ex situ physical/chemical process options evaluated included adsorption, advanced oxidation, air stripping/packed tower, crystallization, dissolved air flotation, evaporation ponds, flocculation/precipitation, granulated activated carbon, ion exchange, physical catalysis, reverse osmosis, sedimentation, sprinkler irrigation, and ultra/micro/nanofiltration.

Adsorption: Adsorption processes involve the displacement of contaminants from one medium to another. Some inorganics have shown good to excellent adsorption potential using activated carbon (see granulated activated carbon, below), alumina, or other media developed for water and wastewater treatment. Spent adsorption media may be regenerated and reused until efficiency declines to a predetermined level. This process option is applicable for inorganic COCs in water but ineffective for explosive COCs. Therefore, this process is retained for surface water and groundwater at Load Line 12.

Advance Oxidation: Advanced oxidation processes including ultraviolet (UV) radiation, ozone, and/or hydrogen peroxide are used to destroy organic contaminants as water flows into a treatment tank. If ozone is used as the oxidizer, an ozone destruction unit is used to treat collected off gases from the treatment tank and downstream units where ozone gas may collect, or escape. This technology may be effective for explosives but is generally inapplicable to inorganic COCs. This process is retained for surface water at Load Line 12.

Air Stripping/Packed Tower: Air stripping involves the addition of large volumes of air to the fluid to be treated. Air stripping is most frequently used for removal of volatile organics and radon gas and is not applicable to surface or groundwater COCs, so it is not retained.

Crystallization: In crystallization, solutes are crystallized from a saturated solution when the solvent is cooled, or water is separated from solution by cooling it until ice crystals form. The process is primarily applicable as a pretreatment or post-treatment process to remove contaminants. It is a poor treatment for explosives and only moderately effective for inorganic COCs and is therefore not retained.

Dissolved Air Flotation: In dissolved air flotation, air is injected while the contaminated water is under pressure. Fine bubbles are released and attach to suspended solids, reducing their specific gravity and aiding their rise to the surface. This technology is not applicable to dissolved contaminants; therefore it is not retained.

Evaporation Ponds: Evaporation ponds involve the evaporation of water and consequent concentration of organic and inorganic wastes. The process is dependent upon climatic conditions and is not practical in non-arid and cold regions, so it is not retained.

Flocculation/Precipitation: Several different precipitants have been shown to effectively remove metals from groundwater. Flocculation is a physical process that agglomerates particles that are too small for gravitational settling. Flocculation results from aggregation due to the random thermal motion of fluid molecules and by velocity gradients in the fluid. This process is retained.

Granulated Active Carbon: Contaminated water is passed ex situ through a filter pack containing granulated activated carbon, which is highly effective at absorbing organic molecules. The carbon filter can be disposed of or "regenerated" for reuse by rinsing with solvents. This process is effective at removing explosives from water. This process is retained for surface water at Load Line 12.

Ion Exchange: Ion exchange has been widely used for the treatment of inorganic wastes. Ion exchange is effective in treating dilute concentrations of contaminants. Exchangers can be produced to remove low concentrations of toxic metals from a wastewater containing a high background concentration of other non-toxic contaminants. This process is retained for inorganic contaminated surface water and groundwater at Load Line 12.

Physical Catalysis: The use of a suitable physical catalyst process allows a substance to be dehalogenated or otherwise reacted from one phase to another. Physical catalysis is generally not feasible for metals and is mostly applicable to halogenated organics. This process is not retained.

Reverse Osmosis: In reverse osmosis, pressure is applied to the solution to force the solvent flow from the more concentrated to the more dilute solution. The membrane through which the solvent flows is impermeable to the dissolved ions. This process is typically used to separate water from inorganic ions. This process is retained for surface water and groundwater at Load Line 12.

Sedimentation: Sedimentation is a post-treatment step that will be retained for possible use in conjunction with flocculation/precipitation. This process is retained for inorganic contaminated surface water and groundwater at Load Line 12.

Sprinkler Irrigation: Sprinkler irrigation passes contaminated water through a standard sprinkler system, which forces VOCs from the dissolved phase into the gaseous. This is not effective at treating metals or explosives, and is not retained.

Ultra/Micro/Nano-Filtration: These filtration techniques use pressure and a semi-permeable membrane to separate nonionic materials from a solvent. This is generally used for suspended solids, oil and grease, large organic molecules, and complex heavy metals, and is not retained.

5.2.5.3 **Biological Treatment**

Biological treatment involves using microbes in situ to degrade or adsorb groundwater contaminants.

Bioremediation: Bioremediation technologies are destruction or transformation techniques directed towards stimulating microorganisms growth and their consumption of the contaminants as a food or energy source. Bioremediation has been successfully used for some heavy metals and is retained for further consideration for surface water and groundwater at Load Line 12.

Biological Sorption: In biological sorption, various active and inactive microorganisms, such as algae and fungi, capable of adsorbing metallic ions are used to remove heavy metals from aqueous solutions. The process takes advantage of the natural affinity for heavy metal ions exhibited by algae cell structures. When the adsorptive capacity of the microorganisms is reached, the metals can be removed and concentrated for subsequent recovery. Biological sorption has been successfully used for some heavy metals and is retained for further consideration for surface water and groundwater at Load Line 12.

Constructed Wetlands: Constructed wetlands use natural geochemical and biological processes inherent in an artificial wetland ecosystem in order to accumulate and remove metals, explosives, and other contaminants from influent waters. The process can use a filtration or degradation process. Although the technology incorporates principal components of wetland ecosystems; including organic soils, microbial fauna, algae, and vascular plants; microbial activity is responsible for most of the remediation. Influent water with explosive residues or other contaminants flows through and beneath the gravel surface of a gravel-based wetland. The wetland, using emergent plants, is a coupled anaerobic-aerobic system. The anaerobic cell uses plants in concert with natural microbes to degrade the contaminant. The aerobic, also known as the reciprocating cell, further improves water quality through continued exposure to the plants and the movement of water between cell compartments (FRTR 2005). This process option is retained.

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 has been retained.

5.2.5.4 **Thermal Treatment**

Thermal treatment uses temperature elevation to initiate a phase change (e.g., liquid to gas) to remove contaminants from groundwater and include incineration and distillation, steam stripping, super critical water oxidation, and wet air oxidation.

Incineration and distillation: Contaminated waters are subjected to very high heat, volatilizing the water and combusting organic contaminants. Inorganic contaminants are typically left as a residue, while the steam and volatilization products are passed through an air filter. This process is potentially applicable for the treatment of explosives; therefore this process is retained for surface water at Load Line 12.

Steam Stripping: Similar to air stripping, except that high temperature steam is bubbled through the contaminated water to trap volatiles and remove them. This process is used mostly for the removal of VOCs and SVOCs and is not retained for further consideration.

Super Critical Water Oxidation: Converts the water into a supercritical fluid using high temperature and pressure. Under these conditions, oxygen is readily dissolved and oxidation processes are greatly enhanced, resulting in near total oxidation of contaminants. This process is potentially applicable for the treatment of explosives; therefore this process is retained for surface water at Load Line 12.

Wet Air Oxidation: Similar to supercritical water oxidation, but involves slightly lower temperatures that do not result in the water becoming a supercritical fluid. This process is potentially applicable for the treatment of explosives; therefore this process is retained for surface water at Load Line 12.

5.2.6 Discharge

Onsite and offsite disposal and discharge options, as well as beneficial reuse, were considered for groundwater. The process options screened included: discharge to surface water, deep well injection, disposal to a POTW or other disposal facility, land spraying/irrigation, and reclamation/recycle/reuse.

5.2.6.1 Onsite Disposal/Discharge

Discharge to surface water and deep well injection were screened. Discharge to surface water could be used as a post-treatment step for treated water and thus the treated water would not need to be transported offsite. Under CERCLA, an NPDES permit is not required for discharge to surface waters; however, the substantive requirements of a permit must be met. Deep well injection involves the injection of either treated or untreated water into an isolated underground zone. This option may be subject to meeting the substantive requirements of permitting. Both options are viable for the RVAAP/RTLS and are retained for further consideration at all scenarios evaluated in this initial screening.

5.2.6.2 Offsite Disposal/Discharge

Among the offsite disposal/discharge options are the use of existing POTWs or other commercial wastewater disposal facilities. Under this option, either treated or untreated water could be sent to these facilities, provided it is in compliance with the facility's permits and waste acceptance criteria. This option is retained for further consideration at Load Line 12, but not further evaluated in this FS. Both options are viable for the RVAAP/RTLS and are retained for further consideration at all scenarios evaluated in this initial screening.

5.2.7 Process Options Retained from Initial Screening

The process options retained through the initial screening are summarized in Table 5-2 to support future considerations regarding the need for remedial action either on an area of concern (AOC)-specific or a facility-wide basis.

Table 5-1. Summary of Process Options Retained from Initial Screening for Groundwater and Surface Water

Process Option
No Action
Institutional Controls
Government Controls
Enforcement Tools
Informational Devices
Legal Mechanisms
Engineering Controls
Physical Mechanism
Environmental Monitoring
Groundwater
Surface Water
Vertical Barriers
Sheet Piles
Semi-permeable Membranes
Slurry Walls
Pumping
Surface Pumping
Vertical Wells
Horizontal Wells
In Situ Physical/Chemical
Geochemical Immobilization
Chelation
Directional Wells
Electrokinetics
Hydrofracturing
Permeable Treatment Wells
Ex Situ Physical/Chemical
Adsorption
Advanced Oxidation
Flocculation/Precipitation
Granulated Activated Carbon
Ion Exchange
Reverse Osmosis
Sedimentation
Biological
Bioremediation
Biological Sorption
Constructed Wetlands
MNA

Table 5-2. Summary of Process Options Retained from Initial Screening for Groundwater and Surface Water (continued)

Process Option
Thermal Treatment
Incineration and Distillation
Supercritical Water Oxidation
Wet Air Oxidation
Onsite
Discharge to Surface Water
Deep Well Injection
Offsite
Existing POTWs
Other CommWW Disposal Facilities

5.2.8 Aqueous Media

COCs identified in impacted groundwater and surface water at Load Line 12 were screened to identify potential remedial options to support future considerations regarding the need for remedial action either on an AOC-specific or a facility-wide basis. Table 5-3 summarizes the process options retained through the initial screening process for impacted groundwater and surface water at Load Line 12.

Table 5-2. Retained Process Options for Groundwater and Surface Water

General Response Action	Technology Type	Process Option
Land Use Controls and Monitoring	Institutional Controls	Government, Enforcement, Informational, Legal Mechanisms
	Engineered Controls	Physical Mechanism
	Environmental Monitoring	Groundwater, Surface Water
Containment	Vertical Barriers	Sheet Piles, Semi-permeable Membranes, Slurry Walls
Removal	Pumping	Surface Pumping, Vertical Wells, Horizontal Wells
Treatment	In Situ Physical/Chemical	Geochemical Immobilization, Chelation, Directional Wells, Electrokinetics, Hydrofracturing, Permeable Treatment Wells
	Ex Situ Physical/Chemical	Adsorption, Advanced Oxidation, Flocculation/Precipitation, Granulated Activated Carbon, Ion Exchange, Reverse Osmosis, Sedimentation
	Biological	Bioremediation, Biological Sorption, Constructed Wetlands, MNA
	Thermal Treatment	Incineration and Distillation, Supercritical Water Oxidation, Wet Air Oxidation
Discharge	Onsite	Discharge to Surface Water, Deep Well Injection
	Offsite	Existing POTWs, Other Commercial Wastewater Disposal Facilities

Table 5-3. Initial Screening of Technology Types and Process Options for Groundwater and Surface Water

General Response Action	Technology Type	Process Options	Description	Screening Comments
No Action	None	None	No remedial technologies implemented to reduce hazards to potential human or ecological receptors.	Required to be carried through CERCLA analysis.
Land Use Controls and Monitoring	Institutional Controls	Government Controls (land use restrictions)	The regulatory authority of a state or local government agency to make land use restrictions and zoning ordinances is used to control the use of the land.	Potentially applicable. May limit future land, groundwater and surface water use options, depending on alternative chosen and the amount of contamination remaining.
		Enforcement Tools (administrative order, consent decrees)	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, advisories)	Registries or advisories put in place to provide information that residual contamination is onsite	
		Legal Mechanisms (contractual mechanisms based on property law)	Easements, deed restrictions, etc. placed on a property as part of a contractual mechanism.	
	Engineered Controls	Physical Mechanisms (fences, berms, warning signs)	Fences, berms, warning signs, and security personnel put in place to prevent contact with contaminated media.	Potentially applicable. Used in conjunction with other alternatives to prevent incidental exposure to contaminated groundwater/surface water.
	Environmental Monitoring	Groundwater	Periodic monitoring of groundwater to keep track of contaminant plumes and concentrations.	Potentially applicable. Used to assist with contaminant control during remedial actions and to monitor performance of treatment alternatives.
		Surface Water	Periodic monitoring of surface waters to ensure that contaminant concentrations remain within acceptable limits.	
Containment	Vertical Barriers	Sheet Piles	Sheet piling is driven into the bed of the stream or lake in order to create a physical barrier to contain contaminated surface waters.	Potentially applicable. Containment technologies do not reduce the volume or toxicity of contaminants, but limit mobility.
		Semi-permeable Membranes	Membranes used as barriers to groundwater movement, containing the spread of a contaminant plume.	
		Slurry Walls	Trenches or directionally drilled tunnels filled with slurry to contain groundwater movement.	

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater and Surface Water (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Removal	Pumping	Surface Pumping	Traditional pumps used to remove contaminated surface water from a water body for treatment or disposal.	Not applicable for groundwater. Potentially applicable for surface water
		Vertical Wells	Traditionally drilled wells to remove groundwater from easily accessible aquifers.	Potentially applicable for groundwater. Not applicable for surface water.
		Horizontal Wells	Directionally drilled wells to remove water from hydraulically isolated water tables, or to avoid surface damage in undesirable locations.	Potentially applicable for groundwater. Not applicable for surface water.
Treatment	In Situ Physical/ Chemical	Air Sparging	Air is introduced to groundwater using horizontal wells to volatilize organic contaminants.	Not applicable. Not effective for inorganic or explosive COCs.
		Geochemical Immobilization	Involves locally adjusting the pH and reduction-oxidation (redox) conditions. This reduces the solubility and/or changes the speciation of contaminants, largely precipitating them in the saturated zone.	Potentially applicable for inorganic COCs.
		Chelation	Chelating agents are used to enhance the in situ solubility or mobility of target constituents.	Potentially applicable for inorganic COCs.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater and Surface Water (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Treatment (continued)	In Situ Physical/ Chemical	Directional Wells	Drilling techniques are used to position wells horizontally, or at an angle, to reach contaminants not accessible by direct vertical drilling.	Potentially applicable for groundwater. Not applicable for surface water.
		Electrokinetics	Electrodes are installed and electrical power used to drive contaminants to the anode for collection in an electrolyte solution.	Potentially applicable for inorganics contamination. Not highly effective for explosive contamination.
		Hydrofracturing	Enhancement method involving pressurized water injection through wells to fracture low permeability and over-consolidated sediments. Fractures are filled with porous media that serve as substrates for bioremediation or to improve pumping efficiency.	Potentially applicable for groundwater. Not applicable for surface water.
		In-Well Air Stripping	Air is injected into a double screened well, lifting the water in the well and forcing it out the upper screen. Simultaneously, additional water is drawn in the lower screen. Once in the well, some of the VOCs in the contaminated ground water are transferred from the dissolved phase to the vapor phase by air bubbles. The contaminated air rises in the well to the water surface where vapors are drawn off and treated by a soil vapor extraction system.	Not applicable. Not effective for inorganic and high explosive COCs.
		Permeable Treatment Walls	These barriers allow the passage of water while causing the degradation or removal of contaminants.	Potentially applicable. Generally intended to control the long term migration of contaminants in groundwater. Technology can be used treating inorganics in groundwater. May be capable of treating high explosive COCs.
		Vacuum Extraction/ Bioslurping	This process option involves the use of vacuum pumps to remove contaminants from groundwater. Bioventing stimulates the aerobic bioremediation of hydrocarbon-contaminated soils.	Not applicable. Technology addresses hydrocarbon-contaminated sites.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater and Surface Water (continued)

General Response Action	Technology Type	Process Options	Description	Screening Comments
Treatment (continued)	Ex Situ Physical/ Chemical	Adsorption	In liquid adsorption, solutes concentrate at the surface of a sorbent, thereby reducing their concentration in the bulk liquid phase.	Potentially applicable for inorganic COCs. Ineffective for high explosive COCs.
		Advanced Oxidation	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.	Potentially applicable. May be effective for high explosive COCs.
		Air Stripping	Large volumes of air are mixed with water in a packed tower to promote partitioning of VOCs to air.	Not applicable. Not effective for inorganic or high explosive COCs.
		Crystallization	Process in which certain solutes crystallize out from a saturated solution when the solvent is cooled.	Not applicable. Separation/crystallization is primarily applicable as a pretreatment or post-treatment process to remove contaminants. Poor treatment results for high explosive COCs. Moderately effective for inorganic COCs.
		Dissolved Air Flotation	Air bubbles are introduced by pressurization/depressurization means, rise to the surface carrying low-density solids.	Not applicable. Not effective for inorganic or explosive COCs.
		Evaporation Ponds	Water is evaporated to concentrate contaminants present in liquid.	Not applicable to cold climate regions.
		Flocculation/ Precipitation	Flocculation is a physical process that agglomerates particles that are too small for gravitational settling. Flocculation results from aggregation due to the random thermal motion of fluid molecules and by velocity gradients in the fluid.	Potentially applicable. Flocculation/precipitation is effective in removing inorganics in groundwater.
		Granulated Activated Carbon	Contaminated water is passed ex situ through a filter pack containing granulated activated carbon, which is highly effective at absorbing organic molecules.	Potentially applicable. Effective at removing high explosive COCs. Multiple contaminants can impact process performance.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater and Surface Water (continued)

General Response Action	General Response Action	General Response Action	General Response Action	General Response Action
Treatment (continued)	Ex Situ Physical/ Chemical (continued)	Ion Exchange	Contaminated water is passed through a resin bed where ions are exchanged between resin and water.	Potentially applicable. Effective for removing inorganics in recovered surface water and groundwater.
		Physical Catalysis	A physical process used to accelerate a chemical change of contaminant.	Not applicable. Physical catalysis is generally not feasible for inorganics and explosives. Option most applicable for halogenated organics.
		Reverse Osmosis	Pressure is applied to force flow from concentrated to dilute solution through a membrane that is impermeable to a solute (dissolved ions).	Potentially applicable. Typically used to separate water from inorganic ions.
		Sedimentation	Suspended particles are allowed to settle depending on the particle diameter and specific gravity in a basin pond or pond enclosure.	Potentially applicable. Sedimentation is a post-treatment step that will be retained for possible use in conjunction with flocculation/precipitation.
		Sprinkler Irrigation	Sprinkler irrigation passes contaminated water through a standard sprinkler system, which forces VOCs from the dissolved phase into the gaseous.	Not applicable. Not effective at treating inorganic or high explosive COCs.
		Ultra/Micro/Nano-filtration	These filtration techniques use pressure and a semi-permeable membrane to separate nonionic materials from a solvent.	Not applicable. Ineffective for inorganic and explosive COCs.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater and Surface Water (continued)

General Response Action	General Response Action	General Response Action	General Response Action	General Response Action
Treatment (continued)	Biological	Bioremediation	Microbiological processes are used to degrade or transform contaminants to less toxic or nontoxic forms, thereby remedying or eliminating environmental contamination.	Potentially applicable. Bioremediation successfully used for treating some heavy metals.
		Biological Sorption	Various active and inactive microorganisms, such as algae and fungi, capable of adsorbing metallic ions are used to remove heavy metals from aqueous solutions. The process takes advantage of the natural affinity for heavy metal ions exhibited by algae cell structures.	Potentially applicable. Inorganic COCs in surface water and groundwater can be removed and concentrated for subsequent recovery.
		Constructed Wetlands	The constructed wetlands-based treatment technology uses natural geochemical and biological processes inherent in an artificial wetland ecosystem to accumulate and remove metals, explosives, and other contaminants from influent waters.	Potentially applicable. Effective in treating inorganic and high explosive COCs.
		MNA	MNA is a passive remedial measure that relies on natural processes to reduce the contaminant concentration over time.	Potentially applicable.
	Thermal Treatment	Incineration and Distillation	Contaminated waters are subjected to very high heat, volatilizing the water and combusting organic contaminants.	Potentially applicable to high explosive COCs. Not effective at treating inorganic COCs.
		Steam Stripping	High temperature steam is bubbled through the contaminated water to trap volatiles and remove them.	Process not applicable. Mostly used from removal of VOCs and SVOCs.
		Supercritical Water Oxidation	Converts the water into a supercritical fluid using high temperature and pressure. Under these conditions, oxygen is readily dissolved and oxidation processes are greatly enhanced, resulting in near total oxidation of contaminants.	Potentially applicable for high explosive COCs. Not effective for inorganic COCs.
		Wet Air Oxidation	Similar to supercritical water oxidation, but involves slightly lower temperatures that do not result in the water becoming a supercritical fluid.	Potentially applicable for high explosive COCs. Not effective for inorganic COCs.

Table 5-1. Initial Screening of Technology Types and Process Options for Groundwater and Surface Water (continued)

General Response Action	General Response Action	General Response Action	General Response Action	General Response Action
Discharge	Onsite	Discharge to Surface Water	Discharges treated or untreated water into a suitable receiving body. May require discharge permits, etc.	Potentially applicable.
		Deep Well Injection	Injects treated or untreated water into a hydraulically isolated deep well for permanent storage. Requires the appropriate geology.	Potentially applicable.
	Offsite	Existing POTWs	Use existing POTW facilities to accept and treat the water. Water can be transported by truck.	Potentially applicable.
		Other Commercial Wastewater Disposal Facilities	Water is transported to a commercial wastewater disposal facility for treatment and disposition.	Potentially applicable.

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Appendix 7
Detailed Cost Estimate

Feasibility Study for Six High Priority AOCs
Load Line 12 - Ravenna Army Ammunition Plant (RVAAP), Ravenna, Ohio
Summary of Alternatives

	Load Line 12 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	$20,888	$242,604	$263,492
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee	30 yr	$176,483	$242,604	$419,087
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$1,794,453	$0	$1,794,453
5	Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee	30 yr	$466,757	$242,604	$709,361
6	Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$3,958,169	$0	$3,958,169

	Load Line 12 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	$20,888	$188,306	$209,194
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee	30 yr	$176,483	$188,306	$364,789
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$1,794,453	$0	$1,794,453
5	Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee	30 yr	$466,757	$188,306	$655,064
6	Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer	<1 yr	$3,958,169	$0	$3,958,169

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
Load Line 12 - 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	10,600	Not Applicable						
3	Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee	10,600	0	774	0	968	0	1,161	1,161
4	Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer	115,078	11,337	794	14,171	993	17,006	1,191	18,197
5	Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee	10,600	0	774	0	968	0	1,161	1,161
6	Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer	115,078	11,337	794	14,171	993	17,006	1,191	18,197

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

Load Line 12 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	10,600	
Civil Survey	day	1.0	Survey AOC areas and set monuments. RSMeans 01107 700 1200.
Civil Survey	$/day	885	
Civil Survey Monuments	ea	8	Assume 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	5	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	36	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	5,130	Analyze samples from 4 wells for metals (6 @ 100), SVOCs (6 @ $220), explosives (6 @ $170), and PCBs (6 @ $80). Analyze 3 soil samples for metals (3 @ 100), SVOCs (3 @ $220), explosives (3 @ $170), and PCBs (3 @ $80). Includes 10% duplicate and 5% rinsate.
Sample Shipment	$/event	100	2 coolers @ $50 ea.
Data Management	hrs	36	Data validation
Data Management	$/hr	60	
IDW Water Disposal	$/lot	700	Includes labor and travel to return IDW water to site after analysis.

Load Line 12 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	events	5	
Sampling and Analysis Reports	$/event	2,800	Assume 40 hours @ $70/hr for report.
Annual O&M Report	events	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	6,100	Assume 80 hours/review @ $70/hr. Add $1000 misc expenses.

Load Line 12 Soil and Sediment
Alternative 2 - Limited Action
Cost Estimate

CAPITAL COST **$20,888**

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)	8	$162.00	$1,296
As Built Drawings (hrs)	8	$60.00	$480
Install Signs on Posts (ea)	5	$185.25	$926
Plans and Reports			
Corrective Action Completion Report (ea)	40	$70.00	$2,800
Subtotal			$12,787
Design		15%	$1,918
Office Overhead		5%	$639
Field Overhead		15%	$1,918
Subtotal			$17,263
Profit		6%	$1,036
Contingency		15%	$2,589
Total			$20,888

Load Line 12 Soil and Sediment
Alternative 2 - Limited Action
Cost Estimate

OPERATION AND MAINTENANCE	$242,604

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	$756	$3,780	$3,452
Sample equipment (events)	5	$1,500	$7,500	$6,850
Analytical Cost (events)	5	$5,130	$25,650	$23,427
Sample Shipment (events)	5	$100	$500	$457
Data Management (events)	5	$2,160	$10,800	$9,864
IDW Water Disposal (events)	5	$700	$3,500	$3,197
Site Inspection and Maintenance				
Site Inspection (ea)	60	$240	$14,400	$9,359
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	$6,100	$36,600	$22,187
Subtotal O&M			$154,230	$119,712
Design		10%	$15,423	$11,971
Office Overhead		5%	$7,712	$5,986
Field Overhead		15%	$23,135	$17,957
Subtotal			$200,499	$155,625
Profit		6%	$12,030	$9,337
Contingency		15%	$30,075	$23,344
Total			$242,604	$188,306

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost)	$263,492

Load Line 12 Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
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	24	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	7,200	Analyze samples for metals (12 @ $100) and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	12	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	10,600	
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	
Civil Survey Monuments	ea	8	Assume monuments around perimeter of AOC. RSMeans 01107 700 0600.
Civil Survey Monuments	$/ea	162	
Install Signs on Posts	ea	5	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	
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. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Volume (In situ)	cy	774	
Soil Excavation Volume (Ex situ)	cy	1,161	Includes soil volume to be transported and disposed.
Soil Excavation Mass	tons	1,277	Includes soil mass to be transported and disposed.
Soil Excavation Surface Area	sf	10,600	
Volume to Weight Conversion	tons/cy	1.10	Exsitu or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	14.79	Includes 3/4 cy excavator, 1 O.E., 1 L.S. spotter, 2 L.S. to prep trucks/and miscellaneous activities. Reduced productivity by 40% for loading trucks, small precise excavations, and security/S&H requirements. Average 160 cy/day. RSMeans Crew B12-F.
Transport and Offsite Disposal			
Transport and Offsite Disposal	tons	1,277	Based on escalated 2004 vendor pricing.
Transport and Offsite Disposal	$/ton	34.80	

Load Line 12 Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Confirmational Sampling & Analysis			
Confirmation Samples	ea	12	Assume average of 1 sample per 2000 sf and 4 sidewall samples. Includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	20	Includes confirmation sampling. Assumes 1 sampling technician at 10 hours/day for 2 days.
Sampling Labor	$/hr	60	
Per Diem	$/event	230	1 person x $115/day
Truck Rental / Gas	$/event	280	1 truck x $90/day. Add $100 for gas.
Confirmation Sample Materials	ea	12	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	1,200	Analyze samples for metals (12 @ $100). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	6	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	1,161	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	22	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 0.5 acres are revegetated for excavation areas and equipment damage.
Seeding, Vegetative Cover	$/MSF	69.75	
Plans and Reports			
Corrective Action Completion Report	hrs	120	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	

Load Line 12 Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
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	
Annual Sampling Labor	days/event	2	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	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	36	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	5,130	Analyze samples from 4 wells for metals (6 @ 100), SVOCs (6 @ $220), explosives (6 @ $170), and PCBs (6 @ $80). Analyze 3 soil samples for metals (3 @ 100), SVOCs (3 @ $220), explosives (3 @ $170), and PCBs (3 @ $80). Includes 10% duplicate and 5% rinsate.
Sample Shipment	$/event	100	2 coolers @ $50 ea.
Data Management	hrs	36	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 O&M Report			
Sampling and Analysis Reports	events	5	
Sampling and Analysis Reports	$/event	2,800	Assume 40 hours @ $70/hr for report.
Annual O&M Report	events	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	6,100	Assume 80 hours/review @ $70/hr. Add $1000 misc expenses.

Load Line 12 Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
Cost Estimate

CAPITAL COST **$176,483**

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)	24	$21.00	$504
Sample Analysis (event)	1	$7,200.00	$7,200
Data Management (hrs)	12	$60.00	$720
Site Work			
Civil Survey (day)	2.0	$885.00	$1,770
Civil Survey Monuments (ea)	8	$162.00	$1,296
As Built Drawings (hrs)	16	$60.00	$960
Install Signs on Posts (ea)	5	$185.25	$926
Clearing (acre)	0.1	$4,025.00	$403
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	774	$14.79	$11,448
Transport and Offsite Disposal (tons)	1,277	$34.80	$44,443
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	20	$60.00	$1,200
Per Diem (event)	1	$230.00	$230
Truck Rental / Gas (event)	1	$280.00	$280
Confirmation Sample Materials (ea)	12	$21.00	$252
Sample Analysis (lot)	1	$1,200.00	$1,200
Data Management (hrs)	6	$60.00	$360
Restoration			
Native Soil Backfill (cy)	1,161	$10.76	$12,487
Seeding, Vegetative Cover (MSF)	22	$69.75	$1,535
Plans and Reports			
Corrective Action Completion Report (ea)	120	$70.00	$8,400
Subtotal			$103,752
Design		15%	$15,563
Office Overhead		5%	$5,188
Field Overhead		15%	$15,563
Subtotal			$140,066
Profit		6%	$8,404
Contingency		20%	$28,013
Total			$176,483

Load Line 12 Soil and Sediment
Alternative 3 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ National Guard Trainee
Cost Estimate

OPERATION AND MAINTENANCE	$242,604

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	$756	$3,780	$3,452
Sample equipment (events)	5	$1,500	$7,500	$6,850
Analytical Cost (events)	5	$5,130	$25,650	$23,427
Sample Shipment (events)	5	$100	$500	$457
Data Management (events)	5	$2,160	$10,800	$9,864
IDW Water Disposal (events)	5	$700	$3,500	$3,197
Site Inspection and Maintenance				
Site Inspection (ea)	60	$240	$14,400	$9,359
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	$6,100	$36,600	$22,187
Subtotal O&M			$154,230	$119,712
Design		10%	$15,423	$11,971
Office Overhead		5%	$7,712	$5,986
Field Overhead		15%	$23,135	$17,957
Subtotal			$200,499	$155,625
Profit		6%	$12,030	$9,337
Contingency		15%	$30,075	$23,344
Total			$242,604	$188,306

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost)	$419,087

Load Line 12 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			
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	60	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	12,840	Analyze samples for metals (12 @ $100), SVOCs (12 @ $220), explosives (12 @ $170), PCBs (12 @ $80), and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	30	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	115,078	
Civil Survey	day	6.0	Survey AOC for additional characterization samples, limits of excavation, and as-builts. RSMeans 01107 700 1200.
Civil Survey	$/day	885	
As Built Drawings	hours	40	Develop as-built drawings.
As Built Drawings	$/hr	60	
Clearing	acre	1.00	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. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Volume (In situ)	cy	12,131	
Soil Excavation Volume (Ex situ)	cy	18,197	Includes soil volume to be transported and disposed.
Soil Excavation Mass	tons	20,016	Includes soil mass to be transported and disposed.
Soil Excavation Surface Area	sf	115,078	
Volume to Weight Conversion	tons/cy	1.10	Exsitu or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	6.48	Inc 1.5 cy excavator, 1 O.E., 1 L.S. spotter, 2 L.S. to prep trucks and miscellaneous activities. Reduced productivity by 25% for loading trucks and security/S&H requirements. Average 400 cy/day. RSMeans Crew B12-F.
Transport and Offsite Disposal			
Transport and Offsite Disposal	tons	20,016	Based on escalated 2004 vendor pricing.
Transport and Offsite Disposal	$/ton	34.80	

Load Line 12 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
Confirmational Sampling & Analysis			
Confirmation Samples	ea	72	Assume average of 1 sample per 2000 sf and 4 sidewall samples. Includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	400	Includes confirmation sampling. Assumes 1 sampling technician at 10 hours/day for 40 days.
Sampling Labor	$/hr	60	
Per Diem	$/event	4,600	1 person x $115/day
Truck Rental / Gas	$/event	4,000	1 truck x $90/day. Add $400 for gas.
Confirmation Sample Materials	ea	288	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	41,040	Analyze samples for metals (72 @ $100), SVOCs (72 @ $220), explosives (72 @ $170), and PCBs (72 @ $80). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	144	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	18,197	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	132	
Seeding, Vegetative Cover	$/MSF	69.75	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 3 acres are 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	

Load Line 12 Soil and Sediment
Alternative 4 - Excavation of Soils/Dry Sediments with Offsite Disposal ~ Resident Subsistence Farmer
Cost Estimate

CAPITAL COST **$1,794,453**

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)	60	$21.00	$1,260
Sample Analysis (event)	1	$12,840.00	$12,840
Data Management (hrs)	30	$60.00	$1,800
Site Work			
Civil Survey (day)	6.0	$885.00	$5,310
As Built Drawings (hrs)	40	$60.00	$2,400
Clearing (acre)	1.0	$4,025.00	$4,025
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	12,131	$6.48	$78,657
Transport and Offsite Disposal (tons)	20,016	$34.80	$696,562
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	400	$60.00	$24,000
Per Diem (event)	1	$4,600.00	$4,600
Truck Rental / Gas (event)	1	$4,000.00	$4,000
Confirmation Sample Materials (ea)	288	$21.00	$6,048
Sample Analysis (lot)	1	$41,040.00	$41,040
Data Management (hrs)	144	$60.00	$8,640
Restoration			
Native Soil Backfill (cy)	18,197	$10.76	$195,703
Seeding, Vegetative Cover (MSF)	132	$69.75	$9,207
Plans and Reports			
Corrective Action Completion Report (ea)	120	$70.00	$8,400
Subtotal			$1,112,632
Design		8%	$89,011
Office Overhead		5%	$55,632
Field Overhead		15%	$166,895
Subtotal			$1,424,169
Profit		6%	$85,450
Contingency		20%	$284,834
Total			$1,794,453

Load Line 12 Soil and Sediment
Alternative 5 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee
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	24	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	7,200	Analyze samples for metals (12 @ $100) and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	12	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	10,600	
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	
Civil Survey Monuments	ea	8	Assume monuments around perimeter of AOC. RSMeans 01107 700 0600.
Civil Survey Monuments	$/ea	162	
As Built Drawings	hours	16	Develop as-built drawings.
As Built Drawings	$/hr	60	
Install Signs on Posts	ea	5	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	
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.
Treatability Study			
Treatability Study	$/lot	45,000	Includes mobilization, treatment of 5 ea. 2 cy batches, analytical testing, and on-site disposal.
Soil Excavation			Includes excavation of the AOC areas based on the areas and depths presented in the summary table. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Volume (In situ)	cy	774	
Soil Excavation Volume (Ex situ)	cy	1,161	Includes soil volume to be treated and backfilled on site.
Soil Excavation Mass	tons	1,277	Includes soil mass to be treated and backfilled on site.
Soil Excavation Surface Area	sf	10,600	
Volume to Weight Conversion	tons/cy	1.10	Exsitu or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	14.79	Includes 3/4 cy excavator, 1 O.E., 1 L.S. spotter, 2 L.S. to prep trucks/and miscellaneous activities. Reduced productivity by 40% for loading trucks, small precise excavations, and security/S&H requirements. Average 160 cy/day. RSMeans Crew B12-F.

Load Line 12 Soil and Sediment

Alternative 5 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee

Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
<u>Ex situ Treatment</u>			Treatment cost are based on the RACER 2005 Solidification cost model. Assume 100% of the waste is solidified and disposed offsite.
Ex situ Treatment	cy	1,161	
Mobilization/Demobilization	ls	10,000	Includes mob/demob of treatment equipment and preparing submittals.
Loading and Transport	hrs	26	Includes 1.25 cy loader and dump truck. ECHOS 17030220 and 17030285.
Loading and Transport	$/hr	240	
Holding Tanks	mo	1	Includes one 550 gal. tank and one 21,000 gal tank. ECHOS 19040401 and 19040401.
Holding Tanks	$/mo	1,900	
Chemical Fixation & Stabilization	tons	240	Chemical Fixation & Stabilization, cement based processes, fixation agents, cement, type 1, bulk shipment. ECHOS 33150405.
Chemical Fixation & Stabilization	$/ton	110	
Urrichem Proprietary Additive	tons	16	
Urrichem Proprietary Additive	$/ton	1,500	ECHOS 33150408.
Operational Labor	hrs	52	Operational labor to operate process equipment. ECHOS 33150420.
Operational Labor	$/hr	67	
Waste Mixer	mo	1	Mixer, 15 cy. ECHOS 33150434.
Waste Mixer	$/mo	7,200	
Solidification Ancillary Equipment	ea	1	ECHOS 33150435.
Solidification Ancillary Equipment	$/ea	11,500	
Maintenance of Solidification Unit	yr	0.10	ECHOS 33150437.
Maintenance of Solidification Unit	$/yr	10,300	
Transport and Offsite Disposal	tons	1,596	Assume 25% increase for solidification process.
Transport and Offsite Disposal	$/ton	34.80	Based on escalated 2004 vendor pricing.
<u>Confirmational Sampling & Analysis</u>			
Treatment Samples - Metals	ea	14	Assume average of 1 metal sample per 100 cy batch. Assume 10% TCLP samples. Includes 10% duplicate and 5% rinsate.
Treatment Samples - TCLP	ea	2	
Confirmation Samples	ea	12	Assume average of 1 sample per 2000 sf and 4 sidewall samples. Includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	30	Includes confirmation sampling. Assumes 1 sampling technician at 10 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	28	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	3,600	Analyze samples for metals (13 @ $100) and TCLP (1 ea @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	14	Data validation
Data Management	$/hr	60	
<u>Restoration</u>			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	1,161	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	22.0	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 0.5 acres are revegetated for excavation areas and equipment damage.
Seeding, Vegetative Cover	$/MSF	46.50	

Load Line 12 Soil and Sediment

Alternative 5 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee

Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Plans and Reports			
Corrective Action Completion Report	hrs	240	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	

Load Line 12 Soil and Sediment
Alternative 5 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee
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	
Annual Sampling Labor	days/event	2	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	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	36	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	5,130	Analyze samples from 4 wells for metals (6 @ 100), SVOCs (6 @ $220), explosives (6 @ $170), and PCBs (6 @ $80). Analyze 3 soil
Sample Shipment	$/event	100	2 coolers @ $50 ea.
Data Management	hrs	36	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 O&M Report			
Sampling and Analysis Reports	events	5	
Sampling and Analysis Reports	$/event	2,800	Assume 40 hours @ $70/hr for report.
Annual O&M Report	events	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	6,100	Assume 80 hours/review @ $70/hr. Add $1000 misc expenses.

Load Line 12 Soil and Sediment
Alternative 5 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee
Cost Estimate

CAPITAL COST	$466,757

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)	24	$21.00	$504
Sample Analysis (event)	1	$7,200.00	$7,200
Data Management (hrs)	12	$60.00	$720
Site Work			
Civil Survey (day)	2	$885.00	$1,770
Civil Survey Monuments (ea)	8	$162.00	$1,296
As Built Drawings (hrs)	16	$60.00	$960
Install Signs on Posts (ea)	5	$185.25	$926
Clearing (acre)	0.1	$4,025.00	$403
Treatability Study			
Treatability Study (lot)	1	$45,000.00	$45,000
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	774	$14.79	$11,448
Ex situ Treatment			
Mobilization/Demobilization (ls)	1	$10,000.00	$10,000
Loading and Transport (hr)	26	$240.00	$6,240
Holding Tanks (mo)	1	$1,900.00	$1,900
Chemical Fixation & Stabilization (tons)	240	$110.00	$26,400
Urrichem Proprietary Additive (tons)	16	$1,500.00	$24,000
Operational Labor (hr)	52	$67.00	$3,484
Waste Mixer (mo)	1	$7,200.00	$7,200
Solidification Ancillary Equipment (ea)	1	$11,500.00	$11,500
Maintenance of Solidification Unit (yr)	0.1	$10,300.00	$1,030
Transport and Offsite Disposal (tons)	1,596	$34.80	$55,554
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	30	$60.00	$1,800
Per Diem (event)	1	$345.00	$345
Truck Rental / Gas (event)	1	$370.00	$370
Confirmation Sample Materials (ea)	28	$21.00	$588
Sample Analysis (lot)	1	$3,600.00	$3,600
Data Management (hrs)	14	$60.00	$840

Load Line 12 Soil and Sediment
Alternative 5 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee
Cost Estimate

Activity (unit)	Quantity	Unit Cost	Total
Restoration			
Native Soil Backfill (cy)	1,161	$10.76	$12,487
Seeding, Vegetative Cover (MSF)	22	$46.50	$1,023
Plans and Reports			
Corrective Action Completion Report (ea)	240	$70.00	$16,800
Subtotal			$269,927
Design		12%	$32,391
Office Overhead		5%	$13,496
Field Overhead		15%	$40,489
Subtotal			$356,303
Profit		6%	$21,378
Contingency		25%	$89,076
Total			$466,757

Load Line 12 Soil and Sediment
Alternative 5 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ National Guard Trainee
Cost Estimate

OPERATION AND MAINTENANCE	$242,604

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	$756	$3,780	$3,452
Sample equipment (events)	5	$1,500	$7,500	$6,850
Analytical Cost (events)	5	$5,130	$25,650	$23,427
Sample Shipment (events)	5	$100	$500	$457
Data Management (events)	5	$2,160	$10,800	$9,864
IDW Water Disposal (events)	5	$700	$3,500	$3,197
Site Inspection and Maintenance				
Site Inspection (ea)	60	$240	$14,400	$9,359
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	$6,100	$36,600	$22,187
Subtotal O&M			$154,230	$119,712
Design		10%	$15,423	$11,971
Office Overhead		5%	$7,712	$5,986
Field Overhead		15%	$23,135	$17,957
Subtotal			$200,499	$155,625
Profit		6%	$12,030	$9,337
Contingency		15%	$30,075	$23,344
Total			$242,604	$188,306

TOTAL ALTERNATIVE CAPITAL AND O&M COST (Non Discounted Cost)	$709,361

Load Line 12 Soil and Sediment

Alternative 6 - Excavation of Soils/Dry Sediments, Treatment, and 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	60	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	12,840	Analyze samples for metals (12 @ $100) and SVOCs (12 @ $220), explosives (12 @ $170), PCBs (12 @ $80), and TCLP (12 @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	30	Data validation
Data Management	$/hr	60	
Site Work			
Site Area	sf	115,078	
Civil Survey	day	4.0	Survey AOC for additional characterization samples, limits of excavation, and as-builts. RSMeans 01107 700 1200.
Civil Survey	$/day	885	
As Built Drawings	hours	40	Develop as-built drawings.
As Built Drawings	$/hr	60	
Clearing	acre	1.00	Assume trees/brush cleared, chipped, and left onsite.
Clearing	$/acre	4,025	RSMeans 022302000200. Clear and chip medium trees to 12" dia.
Treatability Study			Includes mobilization, treatment of 5 ea. 2 cy batches, analytical testing, and on-site disposal.
Treatability Study	$/lot	45,000	
Soil Excavation			Includes excavation of the AOC areas based on the areas and depths presented in the summary table. Ex situ volumes include a 25% constructability factor and 20% swell factor.
Soil Excavation Volume (In situ)	cy	12,131	
Soil Excavation Volume (Ex situ)	cy	18,197	Includes soil volume to be treated and backfilled on site.
Soil Excavation Mass	tons	20,016	Includes soil mass to be treated and backfilled on site.
Soil Excavation Surface Area	sf	115,078	
Volume to Weight Conversion	tons/cy	1.10	Exsitu or loose soil conversion.
Mobilization/Demobilization	ls	5,000	Includes mob/demob of excavation equipment and preparing submittals.
Excavate Soils	$/cy	6.48	Inc 1.5 cy excavator, 1 O.E., 1 L.S. spotter, 2 L.S. to prep trucks/and miscellaneous activities. Reduced productivity by 25% for loading trucks and security/S&H requirements. Average 400 cy/day. RSMeans Crew B12-F.

Load Line 12 Soil and Sediment
Alternative 6 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Ex situ Treatment			Treatment cost are based on the RACER 2005 Solidification cost model. Assume 100% of the waste is solidified and disposed offsite.
Ex situ Treatment	cy	18,197	
Mobilization/Demobilization	ls	10,000	Includes mob/demob of treatment equipment and preparing submittals.
Loading and Transport	hrs	405	Includes 1.25 cy loader and dump truck. ECHOS 17030220 and 17030285.
Loading and Transport	$/hr	240	
Holding Tanks	mo	3	Includes one 550 gal. tank and one 21,000 gal tank. ECHOS 19040401 and 19040401.
Holding Tanks	$/mo	1,900	
Chemical Fixation & Stabilization	tons	3,700	Chemical Fixation & Stabilization, cement based processes, fixation agents, cement, type 1, bulk shipment. ECHOS 33150405.
Chemical Fixation & Stabilization	$/ton	110	
Urrichem Proprietary Additive	tons	250	
Urrichem Proprietary Additive	$/ton	1,500	ECHOS 33150408.
Operational Labor	hrs	810	Operational labor to operate process equipment. ECHOS 33150420.
Operational Labor	$/hr	67	
Waste Mixer	mo	3	Mixer, 15 cy. ECHOS 33150434.
Waste Mixer	$/mo	7,200	
Solidification Ancillary Equipment	ea	1	ECHOS 33150435.
Solidification Ancillary Equipment	$/ea	11,500	
Maintenance of Solidification Unit	yr	0.25	ECHOS 33150437.
Maintenance of Solidification Unit	$/yr	10,300	
Transport and Offsite Disposal	tons	25,020	Assume 25% increase for solidification process.
Transport and Offsite Disposal	$/ton	34.80	Based on escalated 2004 vendor pricing.
Confirmational Sampling & Analysis			
Treatment Samples - Metals, SVOCs, Explosives, and PCBs	ea	211	Assume average of 1 metals, SVOC, Explosive, and PCB sample per 100 cy batch. Includes 10% duplicate and 5% rinsate.
Treatment Samples - TCLP	ea	22	
Confirmation Samples - Metals, SVOCs, Explosives, and PCBs	ea	72	Assume average of 1 sample per 2000 sf and 4 sidewall samples. Includes 10% duplicate and 5% rinsate.
Sampling Labor	hrs	750	Includes confirmation sampling. Assumes 1 sampling technician at 10 hours/day for 75 days.
Sampling Labor	$/hr	60	
Per Diem	$/event	8,625	1 person x $115/day
Truck Rental / Gas	$/event	7,450	1 truck x $90/day. Add $700 for gas.
Confirmation Sample Materials	ea	1,154	Reference ECHOS 33 02 0401/0402 for disposable sampling and decontamination materials.
Confirmation Sample Materials	$/ea	21	
Sample Analysis	$/ea	172,310	Analyze samples for metals (305 @ $100), SVOCs (305 @ $220), explosives (305 @ $170), PCBs (305 @ $80), and TCLP (22 ea @ $500). Includes 10% duplicate and 5% rinsate.
Data Management	hrs	577	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	18,197	ECHOS 17030422, Unclassified Fill, 6" Lifts, Onsite Source, Includes Delivery, Spreading, and Compaction.
Native Soil Backfill	$/cy	10.76	
Seeding, Vegetative Cover	MSF	132	
Seeding, Vegetative Cover	$/MSF	46.50	RSMeans 029203200200. Seeding with mulch and fertilizer. Assume 3 acres are revegetated for excavation areas and equipment damage.

Load Line 12 Soil and Sediment
Alternative 6 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer
Key Parameters and Assumptions

Key Parameters and Assumptions:

Item	Unit	Value	Notes
Plans and Reports			
Corrective Action Completion Report	hrs	300	Includes Construction QC data and preparing report.
Technical Labor	$/hr	70	

Load Line 12 Soil and Sediment
Alternative 6 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer
Cost Estimate

CAPITAL COST	$3,958,169

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)	60	$21.00	$1,260
Sample Analysis (event)	1	$12,840.00	$12,840
Data Management (hrs)	30	$60.00	$1,800
Site Work			
Civil Survey (day)	4	$885.00	$3,540
As Built Drawings (hrs)	40	$60.00	$2,400
Clearing (acre)	1.0	$4,025.00	$4,025
Treatability Study			
Treatability Study (lot)	1	$45,000.00	$45,000
Soil Excavation			
Mobilization/Demobilization (ls)	1	$5,000.00	$5,000
Excavate Soil (cy)	12,131	$6.48	$78,657
Ex situ Treatment			
Mobilization/Demobilization (ls)	1	$10,000.00	$10,000
Loading and Transport (hr)	405	$240.00	$97,200
Holding Tanks (mo)	3	$1,900.00	$5,700
Chemical Fixation & Stabilization (tons)	3,700	$110.00	$407,000
Urrichem Proprietary Additive (tons)	250	$1,500.00	$375,000
Operational Labor (hr)	810	$67.00	$54,270
Waste Mixer (mo)	3	$7,200.00	$21,600
Solidification Ancillary Equipment (ea)	1	$11,500.00	$11,500
Maintenance of Solidification Unit (yr)	0.3	$10,300.00	$2,575
Transport and Offsite Disposal (tons)	20,016	$34.80	$696,562
Confirmational Sampling & Analysis			
Sampling Labor (hrs)	750	$60.00	$45,000
Per Diem (event)	1	$8,625.00	$8,625
Truck Rental / Gas (event)	1	$7,450.00	$7,450
Confirmation Sample Materials (ea)	1,154	$21.00	$24,234
Sample Analysis (lot)	1	$172,310.00	$172,310
Data Management (hrs)	577	$60.00	$34,620
Restoration			
Native Soil Backfill (cy)	18,197	$10.76	$195,703
Seeding, Vegetative Cover (MSF)	132	$46.50	$6,138

Load Line 12 Soil and Sediment

Alternative 6 - Excavation of Soils/Dry Sediments, Treatment, and Offsite Disposal ~ Resident Subsistence Farmer

Cost Estimate

Activity (unit)	Quantity	Unit Cost	Total
Plans and Reports			
Corrective Action Completion Report (ea)	300	$70.00	$21,000
Subtotal			$2,360,549
Design		8%	$188,844
Office Overhead		5%	$118,027
Field Overhead		15%	$354,082
Subtotal			$3,021,503
Profit		6%	$181,290
Contingency		25%	$755,376
Total			$3,958,169