Draft
Feasibility Study for
RVAAP-063-R-01 Group 8 MRS
Version 1.0

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

Contract No. W912DR-15-D-0016
Delivery Order No. 0001

Prepared for:

US Army Corps
of Engineers®

North Atlantic Division, Baltimore District
2 Hopkins Plaza
Baltimore, MD 21201

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This Draft Feasibility Study for RVAAP-063-R-01 Group 8 MRS, Version 1.0 is submitted in support of the Multiple Award Military Munitions Services (MAMMS) Contract No. W912DR-15-D-0016, Task Order 0001. The objective of this FS is to develop, evaluate, and compare remedial action alternatives that will meet the remedial action objectives for the MRS so that the Department of Defense can select and propose an appropriate remedy. This FS used the information obtained during the Remedial Investigation to determine appropriate remedial actions based on the current and anticipated future land uses of the MRS.

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CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

HydroGeoLogic, Inc. (HGL) has completed the *Draft Feasibility Study for RVAAP-063-R-01 Group 8 MRS Version 1.0*, for the former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio. Notice is hereby given that an independent technical review has been conducted that is appropriate to the level of risk and complexity inherent in the project. During the independent technical review, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of data quality objectives; technical assumptions; methods, procedures, and materials to be used; the appropriateness of data used and level of data obtained; and reasonableness of the results, including whether the product meets customer's needs consistent with law and existing USACE policy.

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ARNG – Army National Guard
COR – Contracting Officer's Representative
IED – Installation and Environmental Division
OHARNG – Ohio Army National Guard
RVAAP – Former Ravenna Army Ammunition Plant
USACE – United States Army Corps of Engineers

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AEDB-R	Army Environmental Database - Restoration Module
AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirements
ARNG	Army National Guard
bgs	below ground surface
CB&I	CB&I Federal Services, LLC
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CJAG	Camp James A. Garfield Joint Military Training Center
COC	contaminant of concern
COPEC	contaminant of potential ecological concern
COR	Contracting Officer's Representative
Cr6+	hexavalent chromium
CSM	conceptual site model
CY	cubic yard
DERP	Defense Environmental Response Program
DoD	U.S. Department of Defense
e^2M	engineering-environmental Management, Inc.
EHE	Explosives Hazards Exposure
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FWCUG	Facility-Wide Human Health Cleanup Goals
GRA	general response action
HA	hazard analysis
HE	high-explosive
HGL	HydroGeoLogic, Inc.
HHRA	Human Health Risk Assessment
HQ	hazard quotient
IA	Institutional Analysis
IED	Installation and Environment Division
INRMP	Integrated Natural Resources Management Plan
ISM	incremental sampling methodology
kg-dw/kg-day	kilogram food dry weight per kilogram body weight per day
LUC	land use control
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
mg/kg	milligrams per kilogram
mm	millimeter
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
MRSPP	Munitions Response Site Prioritization Protocol
NCP	National Oil and Hazardous Substances Contingency Plan
NPDES	National Pollutant Discharge Elimination System

O&M	operation and maintenance
OAC	Ohio Administrative Code
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
OSWER	Office of Solid Waste and Emergency Response
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppm	parts per million
PRG	preliminary remediation goal
RAO	remedial action objective
RI	Remedial Investigation
RME	Risk Management Evaluation
ROD	Record of Decision
RSL	regional screening level
RVAAP	Former Ravenna Army Ammunition Plant
S/S	Stabilization/Solidification
SAIC	Science Applications International Corporation
SI	Site Inspection
SVOC	semivolatile organic compound
TBC	to be considered
TCLP	Toxicity Characteristic Leaching Procedure
TOC	total organic compound
TSCA	Toxic Substances Control Act
TSDF	Treatment, Storage, and Disposal Facility
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USP&FO	U.S. Property and Fiscal Officer for Ohio
UU/UE	unlimited use/unrestricted exposure
UXO	unexploded ordnance

EXECUTIVE SUMMARY

Introduction

HydroGeoLogic, Inc. (HGL) has been contracted by the United States (U.S.) Army Corps of Engineers (USACE), North Atlantic Division, Baltimore District, to complete a Feasibility Study (FS) for the Group 8 Munitions Response Site (MRS) (RVAAP-063-R-01) at the Former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This FS is being prepared under Delivery Order No. 0001 of *Multiple Award Military Munitions Services Performance-Based Acquisition* Contract No. W912DR-15-D-0016. The delivery order was issued by the USACE Baltimore District, on August 26, 2016.

This FS was developed to evaluate remedial action alternatives that address the munitions constituents (MC) risks at the MRS that are protective of human receptors in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). This FS evaluates the necessary CERCLA remediation requirements with respect to MC contamination at the Group 8 MRS.

Group 8 MRS History and Background

The Group 8 MRS comprises 2.65 acres within RVAAP. The MRS is located between Buildings 846 and 849, southeast of Load Line #12 and just north of the southern facility boundary. The Group 8 MRS (formerly known as Area Between Building 846 and 849) was used to burn construction debris and rubbish for an unknown period of time. Prior to being designated an MRS, the area between Buildings 846 and 849 was used as a staging area for military vehicles. There are no records available documenting the receipt of munitions at the MRS; however, previous discoveries of munitions and explosives of concern (MEC) and munitions debris (MD) indicated munitions may have been received at the Group 8 MRS. The previous site inspection report summarized MEC discovered on the ground surface by Ohio Army National Guard (OHARNG) personnel in the past and during the 2007 Site Inspection (SI) field activities (e^{2}M, 2008) and recommended the MRS proceed to the RI phase. The remedial investigation (RI) did not confirm the presence of MEC at the MRS and identified MD only. The MD recovered during the RI was verified as material documented as safe (MDAS). The MDAS was described as “MD” in the RI Report but hereinafter will be referred to as MDAS. The MDAS were from the following munitions: M397 series 40 millimeter (mm) high explosive (HE) grenades, M49 series 60mm mortars, 20mm projectiles, M72 series 75mm projectiles, M557 series fuzes, 175mm projectiles, HE anti-tank warheads, and assorted fuzes (CB&I, 2015). The MDAS items were solid and/or inert and did not pose an explosive safety hazard.

The MRS is currently unimproved grassy land characterized by gravel/dirt roads that pass through the center, along the northern border, and in the eastern corner of the MRS. A drainage ditch runs along the southern border of the MRS. During the RI, standing water was observed in the eastern portion of this drainage ditch. The presence of standing water and the water levels vary based on seasonal rainfall. Current activities at the Group 8 MRS include maintenance, natural resource management, sampling, and use as access to adjacent buildings through the existing road network. The future land use for the MRS is expected to be maintenance, natural resource management, sampling, and use of the road network for access to adjacent buildings, and potentially military training, summarized as Commercial/Industrial Land Use. During the RI the Group 8 MRS was assigned a Munitions Response Site Prioritization Protocol (MRSPP) priority of 4. The MRSPP is used to prioritize funding for MRSs on a priority scale of 1 to 8 with a Priority 1 being the highest relative priority.

The MRSPP was revised based on further evaluation of the RI results during the development of this FS. The Group 8 MRS was assigned a MRSPP Score of 5. The Revised MRSPP can be found in Appendix C.

Problem Identification

USACE completed the RI at the Group 8 MRS in May 2015. Several items were identified as material potentially presenting an explosive hazard (MPPEH). Upon inspection, all MPPEH was verified as material documented as safe (MDAS). The MDAS was described as "MD" in the RI Report but hereinafter will be referred to as MDAS. The MDAS items were solid and/or inert and did not pose an explosive safety hazard. Because no MEC was found during the intrusive investigation and the statistical approach was used to select the number of anomalies to investigate, the RI concluded that there is a 99 percent probability that no MEC is present in the anomalies not investigated. During development of this FS, the historical investigations conducted at the MRS and the conclusions of the RI were re-evaluated. The SI reported that in 1996, MEC was found on the MRS (one antipersonnel fragmentation bomb with HE and a demilitarized 175mm projectile) and two T-Bar fuzes (also MEC) were found in 2007. The RI was conducted to determine nature and extent of contamination and included a statistical analysis of investigation results. The conclusion of the RI is that no MEC is present, with a 99 percent confidence level. MDAS items identified during the RI intrusive investigation consisted of the expended 40mm grenades, 20mm projectiles, 60mm projectile, and 75mm projectiles, ammunition cans with residue, and miscellaneous unidentified scrap components. The SI recommended the MRS proceed to the RI phase due to MEC identified historically at the MRS. These findings are inconsistent with the historical findings documented in the SI, as those items are inconsistent with the types of munitions confirmed in the MDAS recovered during the RI intrusive investigation. No additional MEC items have been recovered since the identification of the two items in 1996 and the T-bar fuzes in 2007. Only MDAS, which does not pose an explosive hazard, was recovered during the RI. For these reasons, the historically identified MEC items were removed from consideration for update of the Conceptual Site Model (CSM) resulting in an incomplete exposure pathway for explosive hazards at the MRS. As a result of this CSM update, no further action is recommended for MEC and as a result, this FS addresses only the risks posed by MC-related contamination present at the MRS.

The human health risk assessment (HHRA) conducted as part of the RI determined that contaminants of concern (COCs) in surface soils pose potential risks to the representative receptors at the Group 8 MRS (Resident Receptor [Adult and Child] and the National Guard Trainee). An ecological risk assessment was also conducted during the RI and determined that contaminants of potential ecological concern (COPECs) in surface soil have the potential to impact soil invertebrates and small range receptors. Due to the establishment of the *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant (RVAAP) Installation Restoration Program* (Technical Memorandum; ARNG, 2014), the Industrial Receptor was not evaluated during completion of the RI Report. Because the HHRA in the RI Report did not evaluate potential risks to the Industrial Receptor, this FS assesses potential risks to the Industrial Receptor in Section 2.1.2.4 and determined that no risk from MC is present. This FS summarizes that soil contaminants do not pose a risk to the Industrial Receptor, who is the receptor under current land use. Due to the MC risks summarized in Section 2.1.2.4 for the Residential Receptor (the receptor required to be evaluated to meet unlimited use/unrestricted exposure [UU/UE]) and the National Guard Trainee (a potential future receptor for the potential future land use of military training); these receptors were evaluated during development of the remedial action objectives (RAOs). Any remediation accomplished for the Resident Receptor (Adult and Child) by remediating GR8SS-004M will also be considered protective of the National Guard trainee and the Industrial Receptor.

Remedial Action Objectives

The RAOs are developed to determine the effectiveness of the remedial action based on the CSM for the MRS and are focused on limiting or removing exposure pathways for MC (U.S. Army, 2009). RAOs specify the contaminant(s) and media of concern, potential exposure pathways, and the remediation goals (40 Code of Federal Regulations [CFR] § 300.430[e][2][i]). The RAOs for the MRS address the overall goal of protecting human and ecological receptors from risk due to MC-contaminated soil. The RAOs and this FS address the potential risk from MC contamination in soils remaining at the MRS. Primary media of concern for MC at the MRS is surface to 0.5 feet bgs and is applicable for the Residential Receptor (for evaluation of UU/UE) and National Guard Trainee receptor (a potential future receptor). The following RAOs were developed for the MRS:

- Prevent exposure of a theoretical future Resident Receptor (Adult and Child) to human health COCs (cadmium) in surface soils (0 to 0.5 foot bgs) which exceed risk-based remediation goals (see Section 2.4.1). The Land Use that would be obtained that would allow for UU/UE, is Unrestricted (Residential) Land Use for the Resident Receptor.

Development of Screening Alternatives

This FS identifies and screens remedial technologies and associated process options that may be appropriate for satisfying the RAOs for the Group 8 MRS. Evaluation of remedial technology types and process options is a two-step process. The first step is an initial screening of technologies and process options. This is generally done on the basis of technical implementability in order to eliminate process options or entire technology types that would clearly be ineffective or unworkable considering MRS and MC risks. The second step in this process is to evaluate the process options considered to be technically implementable in greater detail with respect to effectiveness, implementability, and cost in order to select the representative process for each technology type. Although these are the same criteria used to screen remedial alternatives prior to detailed analysis, at this stage these criteria are applied only to technologies and process options and not to MRS-wide alternatives. In addition, the evaluation of process options focuses more on assessing effectiveness and less on implementability and cost. Select remedial technologies and process options were carried forward after the evaluation of the remedial technologies types and process options and were combined to develop the following remedial alternatives for the MRS:

- Alternative 1, No Action—The *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP) (40 CFR Part 300) requires that a "No Action" alternative be evaluated to provide a baseline for comparison to other alternatives. This alternative provides no actions to protect receptors at the MRS.
- Alternative 2, Land-Use Controls (LUCs)—Under this alternative, no removal would be conducted to reduce potential hazards. Rather, measures would be taken to modify human behavior that would limit exposures to COCs on the MRS. There would be no measured reduction in toxicity, mobility, or volume through treatment of MC at the MRS. LUCs would be implemented and would focus on reducing potential human exposure to MC by managing and monitoring the activities occurring at the MRS.
- Alternative 3, MC Contaminated Soil Removal—This alternative includes the removal of MC contaminated soil on or just below the ground surface (0 to 0.5 feet bgs) at the MRS at the location of GR8SS-004M. Confirmation soil sampling would be completed to confirm the complete removal

of contamination and proper disposal of excavated soils. Implementation of this alternative would lead to a negligible probability of exposure, or UU/UE for the theoretical future Resident Receptor (Unrestricted [Residential] Land Use).

Once the remedial alternatives were assembled, they were described and preliminarily screened against the three criteria of effectiveness, implementability, and cost. All three alternatives were retained for detailed analysis.

The detailed analysis was then completed for each retained alternative using nine evaluation criteria, as defined by the NCP. The purpose of the detailed analysis was to evaluate and compare the identified remedial alternatives and to develop a Proposed Plan for regulatory and public review.

Evaluation of Screening Alternatives

Based on the results of the RI and further evaluation of those results in this FS, MC hazards in surface soils are present at the MRS and pose human health risks. The NCP statutory preference for reduction of toxicity, mobility, or volume through treatment is best achieved with Alternative 3, which would result in a negligible probability of exposure for the Residential Receptor for MC risks (i.e., UU/UE) and eliminate the source of MC contamination. Based on the evaluation of the NCP criteria, Alternative 2 (LUCs) and Alternative 3 (MC Contaminated Soil Removal) are acceptable to implement. The deciding factor will be the alternative that best meets the RAOs and is technically and administratively implementable.

Using the comparative analysis of the alternatives presented in this FS, a preferred alternative will be presented to the public for review, and comment in the Proposed Plan for this MRS. A remedy will then be selected for this MRS and presented in the Record of Decision. Table ES-1 provides a summary of the detailed analysis of alternatives in comparison to the nine NCP criteria.

Table ES-1 Summary of Detailed Analysis of Alternatives

CERCLA Evaluation Criteria	Remedial Alternatives		
	Alternative 1 No Action	Alternative 2 LUCs	Alternative 3 MC Contaminated Soil Removal (UU/UE)
Protective of Human Health and Environment	No	No	Yes
Complies with ARARs	Yes	Yes	Yes
Effective and Permanent	No	No	Highest
Reduces Toxicity, Mobility, or Volume	None (no treatment)	None (no treatment)	Removal of MC to achieve UU/UE for Resident Receptor
Short-Term Effectiveness	Low	Medium	Low
Implementable	Easy to implement	Easy to implement	Most difficult to implement
Costs			
Capital	$0	$20,445	$587,690
O&M (discounted)	$0	$77,608	$0
Periodic (discounted)	$0	$27,851	$0
Present Worth (Capital + discounted O&M +discounted Periodic Costs)	$0	$125,904	$587,690
Five-Year Reviews (discounted)	$0	$94,175	$0
State Acceptance		To be determined	
Community Acceptance		To be determined	

ARAR denotes applicable or relevant and appropriate requirement.

CERCLA denotes Comprehensive Environmental Response, Compensation, and Liability Act of 1980.

LUC denotes Land Use Control

MC denotes munitions constituents

O&M Operation and Maintenance

UU/UE denotes Unlimited Use/Unrestricted Exposure, Unrestricted (Residential) Land Use

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1.0 INTRODUCTION

HydroGeoLogic, Inc. (HGL) has been contracted by the United States (U.S.) Army Corps of Engineers (USACE), North Atlantic Division, Baltimore District, to complete a Feasibility Study (FS) for the Group 8 Munitions Response Site (MRS) at the Former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This FS is being prepared under Delivery Order No. 0001 of *Multiple Award Military Munitions Services Performance-Based Acquisition* Contract No. W912DR-15-D-0016. The delivery order was issued by the USACE, Baltimore District, on August 26, 2016.

1.1 Regulatory Framework and Authorization

The U.S. Department of Defense (DoD) has established the Military Munitions Response Program (MMRP) under the Defense Environmental Restoration Program (DERP) to address DoD sites suspected of containing munitions and explosives of concern (MEC) and/or munitions constituents (MC). Pursuant to Manual Number 4715.20: DERP Management (DERP Manual; DoD, 2012), USACE is conducting MMRP activities in accordance with the DERP statute (10 U.S. Code [USC] § 2701 et seq.), the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 USC § 9620), Executive Orders 12580 and 13016, and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] Part 300). While not all MEC/MC constitute CERCLA hazardous substances, pollutants, or contaminants, the DERP statute provides the DoD the authority to respond to releases of MEC/MC, and DoD policy states that such responses shall be conducted in accordance with CERCLA and the NCP. The Remedial Investigation (RI) report used "MEC" as the term for items determined to be explosively hazardous.

1.2 Purpose

The purpose of this FS is to develop, evaluate, and compare remedial action alternatives that will meet the remedial action objectives (RAOs) so that the DoD can select and propose an appropriate remedy for the MRS. This FS used the information obtained during the RI phase of the CERCLA process to perform a systematic analysis to determine appropriate remedial actions based on current and anticipated future land uses. This FS was developed in accordance with the *Final United States Army Munitions Response Program Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009) and in accordance with U.S. Environmental Protection Agency (EPA) guidance documents developed for activities performed under CERCLA, as outlined in the NCP. The EPA guidance documents include, but are not limited to, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (RI/FS Guidance; EPA, 1988) and *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA, 2000).

1.3 Physical Setting and Administrative Control

The RVAAP (Federal Facility Identification No. OH213820736), now known as Camp James A. Garfield Joint Military Training Center (CJAG), is located in northeastern Ohio within Portage and Trumbull Counties and is approximately 3 miles east–northeast of the city of Ravenna. The facility is approximately 11 miles long and 3.5 miles wide. The facility is bounded by State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; Garret, McCormick, and Berry Roads to the west; the Norfolk Southern

Railroad to the north; and State Route 534 to the east. In addition, the facility is surrounded by the communities of Windham, Garrettsville, Newton Falls, Charlestown, and Wayland (Figure 1-1).

Administrative control of the 21,683-acre facility has been transferred to the U.S. Property and Fiscal Officer (USP&FO) for Ohio and subsequently licensed to the Ohio Army National Guard (OHARNG) for use as a training site, CJAG. The Army National Guard (ARNG) and OHARNG oversee the cleanup of former production areas across the facility related to former operations under the RVAAP and utilizes the Installation Restoration Program, the Compliance-Related Cleanup Program, and the MMRP to implement the cleanup work.

The Group 8 MRS is 2.65 acres located in the southeastern portion of the facility (Figure 1-2). The MRS is currently unimproved grassy land characterized by a network of gravel/dirt roads and a drainage ditch along to the southernmost border (Figure 1-3). The MRS was used for an undetermined amount of time to burn construction debris and rubbish, and was used by the OHARNG as a vehicle staging area until it was designated as a MRS. The OHARNG currently utilizes the road network within the MRS to access adjacent buildings.

Table 1-1 Administrative Summary of the Group 8 MRS

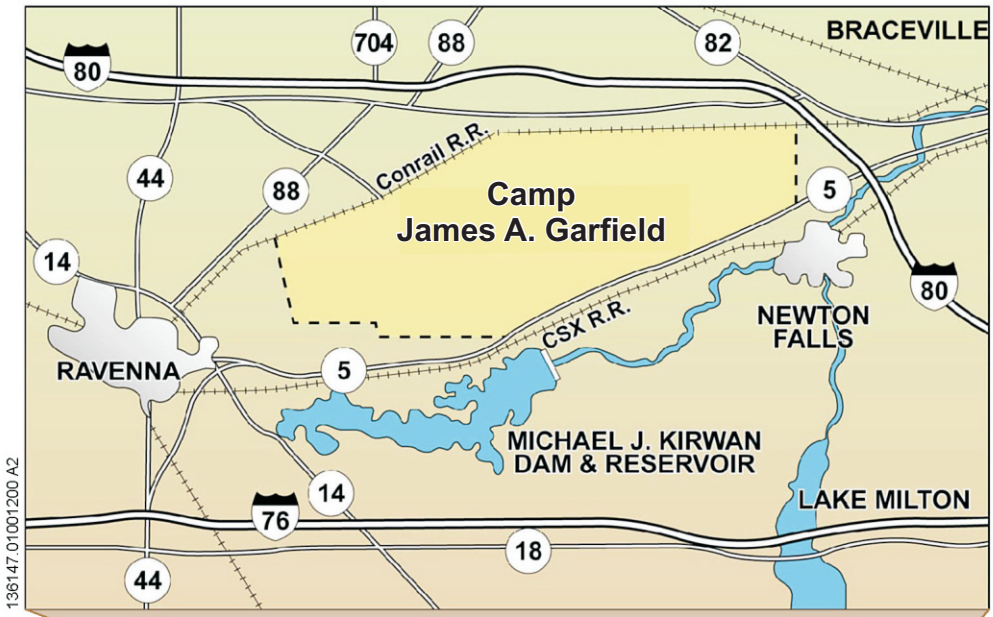
Investigation Area	AEDB-R MRS Number	Area (Acres)	Property Owner	MRS Management Responsibility
Group 8 MRS	RVAAP-063-R-01	2.65	USP&FO for Ohio	ARNG/OHARNG

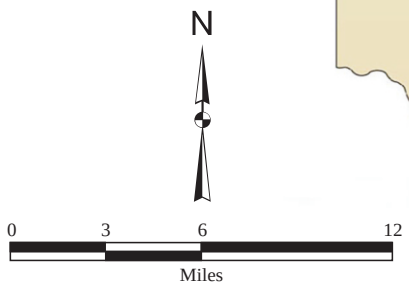
ARNG *denotes* Army National Guard
AEDB-R *denotes* Army Environmental Database Restoration Module
MRS *denotes* Munitions Response Site
OHARNG *denotes* Ohio Army National Guard
USP&FO *denotes* U.S. Property and Fiscal Officer for Ohio

The *Facility-Wide Institutional Analysis for the Former Ravenna Army Ammunition Plant* institutional analysis (IA) presented as Appendix A identifies land use control (LUC) technologies, identifies those entities having jurisdiction over CJAG; and assesses the appropriateness, capability, and willingness of OHARNG to implement and maintain LUCs at CJAG. The IA determined that ARNG has financial capability to implement LUCs at the facility and coordinates the implementation with OHARNG. OHARNG is willing to implement, maintain, and enforce LUCs at this MRS should they be identified as part of the chosen alternative.

1.4 MRS Description

Group 8 MRS is currently vacant, grassy land with gravel roads as shown in Figure 1-3. Topography at the MRS is flat and the relative elevation is approximately 985 feet above sea level. There are no permanent surface water features within the MRS, and it is not located within a floodplain. Surface water drainage generally flows into drainage ditches along the roadside where it infiltrates the soil. The approximate depth to groundwater in the unconsolidated aquifer is between 15 to 20 feet below ground surface (bgs), and flow direction is towards the southeast. Bedrock at the MRS is approximately 975 feet above sea level, and is within the Sharon Member conglomerate unit. Soils in Group 8 MRS are silt or clay loams, identified as Mahoning-Urban land complex, with undulating 2 to 6 percent slopes (CB&I, 2015).





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3/21/2019 JG
Source: CB&I

Legend

Camp James A. Garfield

Note:
RVAAP=Ravenna Army Ammuntion Plant

Figure 1-1
Location Map
Camp James A. Garfield/ Former RVAAP
Portage and Trumbull Counties, Ohio

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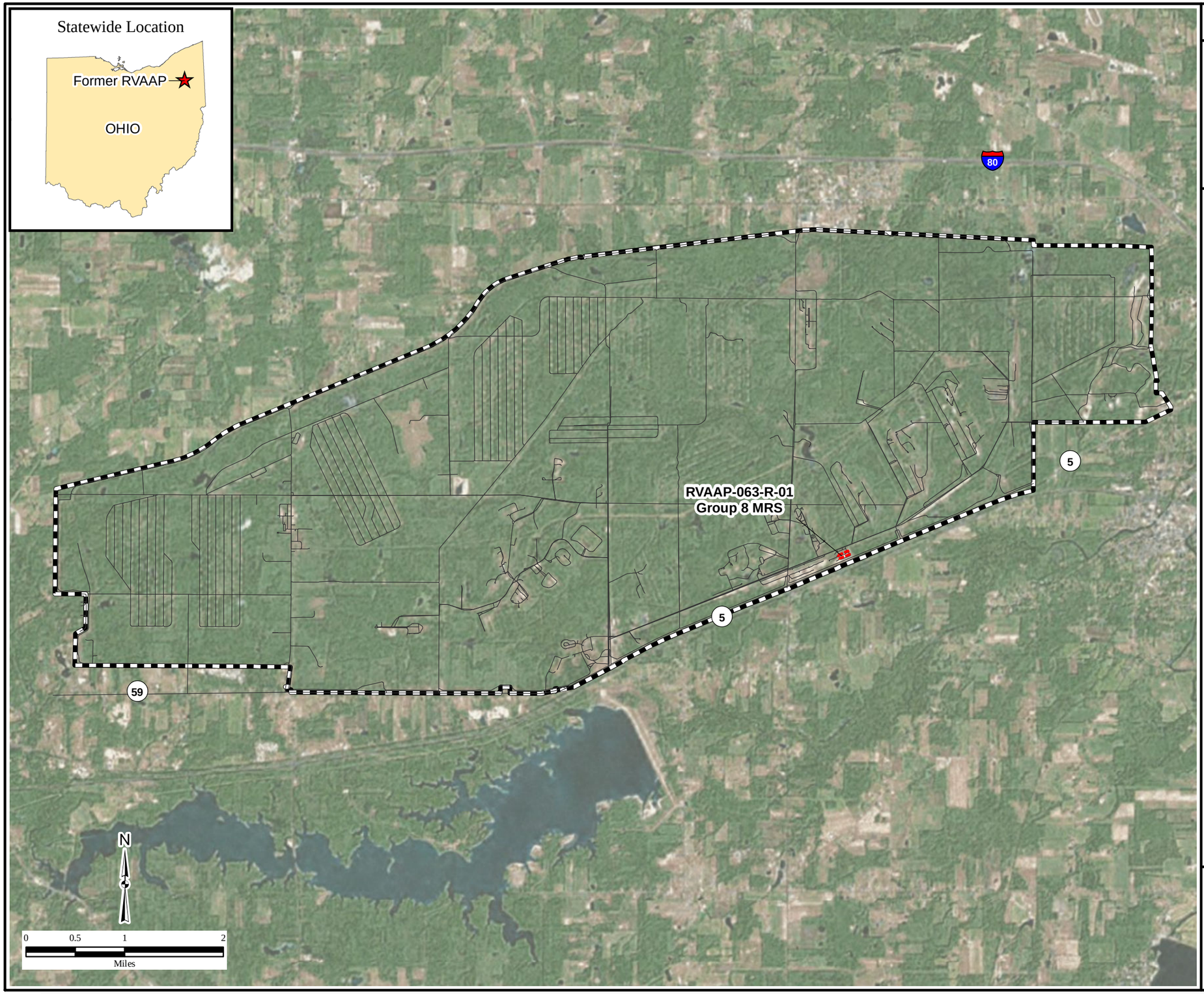

HGL—Feasibility Study
Former RVAAP, Ohio

Figure 1-2
MRS Location
Group 8
Former RVAAP
Portage and Trumbull Counties, Ohio

Legend

- Road
- MRS
- Installation Boundary

Notes:
MRS=munitions response site
RVAAP=Ravenna Army Ammunition Plant

\\Gst-srv-01\hglgis\Ravenna_AAP\Group8\FS\(1-02)Group8_Site_Map.mxd
5/9/2017 JAR
Source: HGL,CB&I, USACE, e²M ArcGIS Online Imagery

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HGL—Feasibility Study
Former RVAAP, Ohio

Figure 1-3
Site Features
Group 8 MRS
Former RVAAP
Portage and Trumbull Counties, Ohio

Legend

- Utility Pole
- Standing Water
- MRS
- Installation Boundary

Notes:
MRS=munitions response site
RVAAP=Ravenna Army Ammunition Plant

\\Gst-srv-01\hglgis\Ravenna_AAP\Group8\FS
(1-03)Group8_Site_Features.mxd
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Source: HGL,CB&I, USACE, e²M
ArcGIS Online Imagery

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1.5 Current and Projected Land Use

The human health risk assessment in the RI was completed prior to the completion of the *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant (RVAAP) Installation Restoration Program* (Technical Memorandum; ARNG, 2014). The Technical Memorandum was prepared by the ARNG and the Ohio Environmental Protection Agency (Ohio EPA) to amend the risk assessment process to address changes in the RVAAP restoration program. The Technical Memorandum defined three Categorical Land Uses and Representative Receptors to be considered during the RI phase of the CERCLA process. The three land uses and representative receptors are as follows:

1.) Unrestricted (Residential) Land Use (UU/UE) – Resident Receptor (Adult and Child) (formerly called Resident Farmer)

2.) Military Training Land Use – National Guard Trainee

3.) Commercial/Industrial Land Use – Industrial Receptor (EPA Composite Worker)

RI reports that were substantially in progress at the time of the Technical Memorandum's approval on February 11, 2014, as was the case for the *Final Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, Version 1.0* (Final RI Report; CB&I, 2015), were not revised to include an evaluation of the Industrial Receptor in the human health risk assessment process. If Unrestricted (Residential) Land Use was not achieved for explosive hazards and/or MC during the risk assessment process in the RI, then the Industrial Receptor would be evaluated during the FS when there is a possibility that a full-time occupational exposure may occur on the MRS.

The current land use activities at the MRS are maintenance, natural resource management, sampling, and an access route to adjacent buildings through the existing road network. The MRS is not currently used for military training, but military training is a potential future land use. The RI report identified the National Guard Trainee as the Representative Receptor based on the potential future land use of military training. The future land use activities at the MRS are maintenance, natural resource management, environmental sampling, and military training. For this FS, the Industrial Receptor and the National Guard Trainee are evaluated as potential receptors as these receptors best reflect current land use and are representative of potential future land use. The primary media of concern for the Industrial Receptor is surface and subsurface soils to a maximum exposure depth of 4 feet bgs. Both the National Guard Trainee and the Industrial Receptor are evaluated as potential receptors for MC risk in the surface soils at the Group 8 MRS.

1.6 Report Organization

The organization of this FS, including the specific sequence of steps used to develop, screen, and analyze remedial alternatives, is as follows:

- Section 1.0 – Introduction: This section describes the regulatory framework, purpose, and property identification; background information on the MRS; and previous investigations.
- Section 2.0 – Project Objectives: This section presents the conceptual site model (CSM) and potential Applicable or Relevant and Appropriate Requirements (ARARs), defines the RAOs, and discusses institutions that may be responsible for implementing LUCs that will be considered in the development and analysis of remedial alternatives.

- Section 3.0 – Identification and Screening of Technologies: This section identifies the range of applicable general response actions (GRAs) and technologies for risk management, and provides an initial screening of such GRAs and technologies to assess whether they should be included as part of a remedial alternative.
- Section 4.0 – Development and Screening of Alternatives: This section presents the various remedial alternatives developed for Group 8 MRS, identifies the ARARs potentially associated with each alternative, and provides a preliminary screening of the effectiveness, implementability, and cost of each alternative.
- Section 5.0 – Detailed Analysis of Alternatives: This section presents a detailed evaluation of each remedial alternative developed and retained after the screening process discussed in Section 4.0. The evaluation is based on the nine criteria in the NCP: protection to human health and the environment; compliance with ARARs; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; cost; state acceptance; and community acceptance.
- Section 6.0 – Comparative Analysis of Alternatives: This section presents a comparison of the alternatives based on the results of the detailed analysis of alternatives presented in Section 5.0.
- Section 7.0 – References: This section provides a list of references for pertinent documents cited in this FS.

2.0 PROJECT OBJECTIVES

This section presents a summary of the CSM findings in the RI and the updated CSM and the RAOs for the Group 8 MRS. The RAOs were established through consideration and analysis of the updated MEC CSM for the MRS as well as an evaluation of potential ARARs that may be triggered as a result of the remedial alternatives selected to achieve the RAOs. Section 2.1 describes the current CSM and discusses any changes made to the CSM following the RI.

2.1 Conceptual Site Model

The information collected during the RI and the conclusions presented in the Final RI Report (CB&I, 2015) were used to update the MEC and MC CSMs in this FS and identify complete, potentially complete, or incomplete source-receptor interactions for the MRS, for both current and reasonably anticipated future land uses. A CSM has three sections: Sources, Interaction, and Receptors for explosive hazards or MC, with the exposure pathways identified for each receptor. Each section is discussed below:

- Sources: Sources are those areas where explosive hazards or MC has entered (or may enter) the physical system. A source is the location where explosive hazards or MC contamination is situated or expected to be found.
- Interactions: Explosive hazards or risks from MC contamination, arise from direct contact as a result of some activity by human receptors or (for MC) activity by ecological receptors. Interactions describe ways that receptors come into contact with a source.
- Receptors: A receptor is an organism (human or ecological) that contacts a chemical or physical agent. The pathway evaluation must consider both current and reasonably anticipated future land use, as receptors are determined on that basis.

The RI was completed in 2015 and determined the nature and extent of MEC and MC at the Group 8 MRS and determined the hazards and potential risks posed to the likely receptors identified at that time. Based on the CSM findings in the RI, it was recommended that the MRS proceed to a FS as the next course of action under the MMRP. The applicable receptors presented in the RI report CSMs have been revised in the FS CSMs as discussed in Section 1.4. The RI CSMs presented the National Guard Trainee and Biota as the applicable receptors. The information collected during the RI field activities and the changes following the completion of the RI that were used to update the CSM for the Group 8 MRS is presented in Table 2-1 and Figure 2-1a and Figure 2-1b. The FS CSMs (Figure 2-1a and Figure 2-1b) now include the Industrial Receptor.

2.1.1 MEC Exposure Pathway Analysis

An exposure pathway is the course a chemical or physical agent takes from a source to a receptor. Each potential MEC pathway includes a source, interaction (access and activity), and a receptor. A pathway is considered complete when a source is known to exist and when receptors have access to the MRS while engaging in some activity that results in contact with the source. A pathway is considered potentially complete when a source has not been confirmed, but is suspected to exist and when receptors have access to the MRS while engaging in some activity which results in contact with the source. Lastly, an incomplete pathway

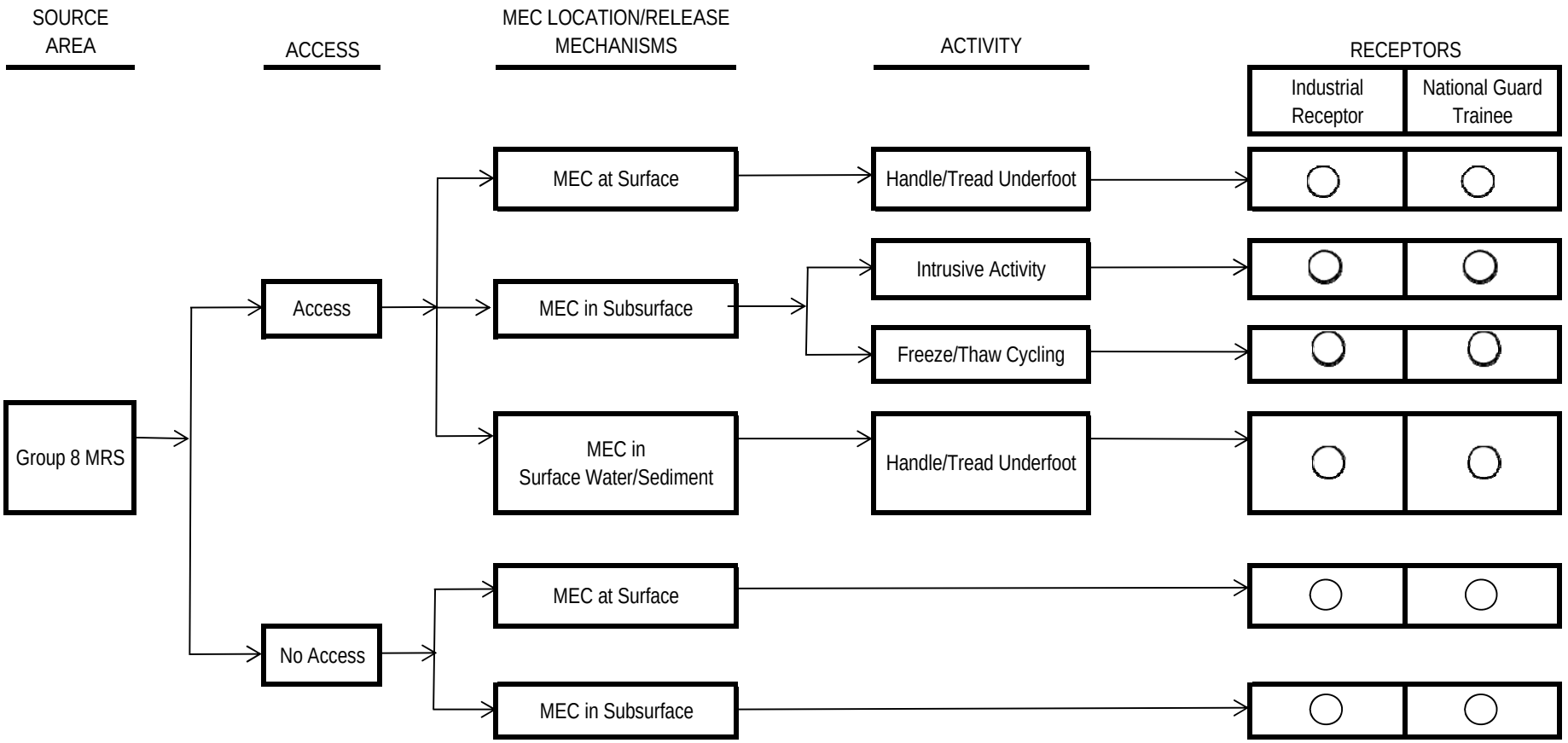
is any case where one of the four components (source, activity, access, or receptors) is missing from the MRS.

Table 2-1 Summary of CSM Findings

Description	CSM Finding
Location Profile	
Boundaries	2.65 acres of unimproved grassy land crossed by gravel roads and located within the MRS boundary. The MRS is located between Buildings 846 and 849, southeast of Load Line #12 and north of the southernmost CJAG boundary.
Structures	No structures are located within the MRS.
Utilities	Utility poles for overhead lines are located within the MRS.
Security	Access to the facility is controlled; however, once on the facility, access to the MRS is unrestricted.
Land Use and Receptors	
Current Land Use	Maintenance, natural resource management, and environmental sampling
Potential Future Land Use	Maintenance, natural resource management, environmental sampling, and military training
Human Receptor(s)	Industrial Receptor and National Guard Trainee
Wetlands and Sensitive Areas	No wetlands are located within the MRS.
Cultural Resources	A cultural resource survey has been conducted at this MRS. No eligible resources were found. Additionally, the area is highly disturbed.
MEC and MC Exposure	
MEC Exposure	• 359 MDAS items identified from 1 inch bgs to 4 feet bgs • No MEC identified during the RI • No MEC hazard (no explosives hazard) are present at the MRS
MC Exposure	Based on the evaluation in this FS, the following MC risk exists to the following receptors: • Unacceptable risk due to MC-related contamination exists to the theoretical future receptors (National Guard Trainee and Resident Receptor [Adult and Child]) for cadmium in surface soils (0 to 0.5 foot bgs) (see Section 2.1.2).

bgs denotes below ground surface
CJAG denotes Camp James A. Garfield Joint Military Training Center
CSM denotes conceptual site model
FS denotes Feasibility Study
MC denotes munitions constituents
MDAS denotes material documented as safe.
MEC denotes munitions and explosives of concern
MRS denotes Munitions Response Site
RI denotes Remedial Investigation

FIGURE 2-1a. MEC CONCEPTUAL SITE MODEL
RVAAP-063-R-01 GROUP 8 MRS



Complete Pathway
Potentially Complete Pathway
Incomplete Pathway

Receptor Exposure Scenarios (feet bgs)		
Receptor	Surface/Sediment	Subsurface
Industrial Receptor	0	0 to 4

See Table 2.1.1 in the FS text for additional details of the CSM.

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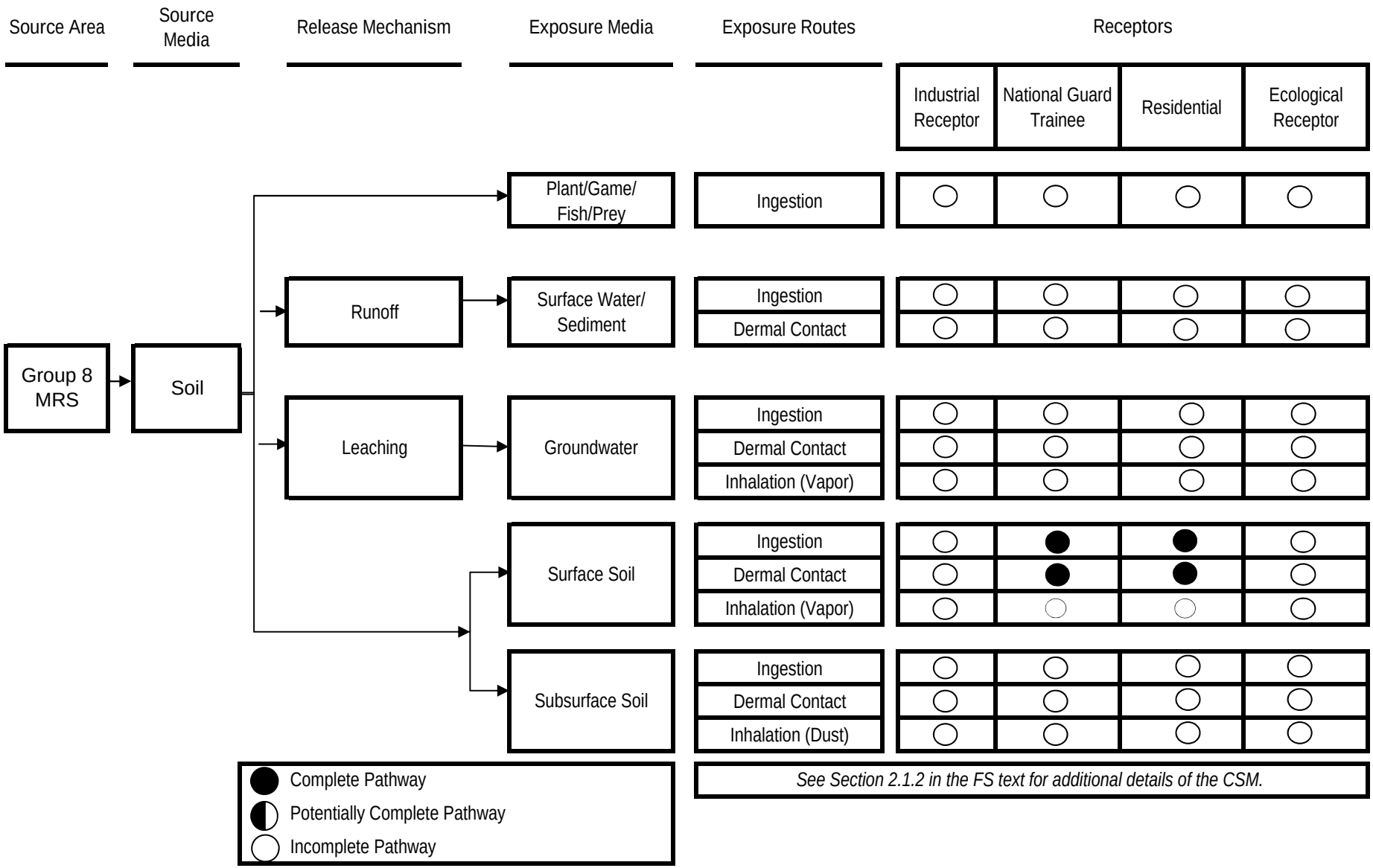
FIGURE 2-1b. MC CONCEPTUAL SITE MODEL
RVAAP-063-R-01 GROUP 8 MRS



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2.1.1.1 Source

There is currently no known source of MEC on the MRS. As recommended in the 2007 Site Inspection (SI), the RI was completed at the Group 8 MRS in 2015 to determine the nature and extent of MEC and to identify the associated hazards. However, no MEC was found during the RI. A total of 264 single point anomalies and 14 exploratory trenches within 3 areas of high anomaly density were investigated. In general, the geophysical data indicated that the anomaly density is high and dispersed throughout the MRS, with localized higher density areas located south of the gravel roadway. During intrusive investigation of those anomalies, approximately 1,400 pounds of material potentially posing an explosive hazard (MPPEH) were recovered and identified as material documented as safe (MDAS). The MDAS items were all between 1 inch bgs and 4 feet bgs (Figure 2-2). MDAS items identified during the RI intrusive investigation consisted of expended 40 millimeter (mm) grenades, 20mm projectiles, 60mm projectile, and 75mm projectiles, ammunition cans with residue, and miscellaneous, unidentified and inert munitions components. None of the items were explosively configured or otherwise identified as MEC.

MEC was reportedly encountered at the MRS during previous investigations. In 1996, OHARNG personnel reportedly found one antipersonnel fragmentation bomb with high explosive (HE) on the ground surface. Also in 1996, one piece of a demilitarized [i.e., cut in half] 175mm projectile was discovered. During the 2007 SI, two T-bar fuzes partially buried in surface soils were confirmed to be MEC. None of these items are consistent with the MDAS items found during the RI, no MEC has otherwise been reported since 2007, and the RI concluded with a 99 percent confidence level that no MEC are present. Therefore, no explosive hazard is anticipated and the MEC exposure pathway is considered incomplete. As of this writing, no further action is recommended with respect to MEC for the Group 8 MRS.

Because only MDAS was found during the RI, MEC was not confirmed during the RI field activities.

2.1.1.2 Receptors

A receptor for the CSM is any human who comes into physical contact with a potential explosive hazard. The future land use for the Group 8 MRS consists of maintenance, natural resource management, environmental sampling activities, and military training. The National Guard Trainee was identified as the representative receptor for the MRS in the RI; however, in accordance with the Technical Memorandum (ARNG, 2014), the human receptor that has the greatest opportunity for exposure to explosive hazards or MC at the MRS is the Industrial Receptor. The Industrial Receptor represents a full-time occupational receptor at the MRS whose activities are consistent with full-time employees or career military personnel who are expected to work daily at the facility over their career. The Industrial Receptor typically contacts only the surface soil. Additionally, as detailed further in Section 2.1.2.4, conditions that achieve Unrestricted (Residential) Land Use for the Resident Receptor (Adult and Child) are considered protective of other receptors including military training (National Guard Trainee Receptor) and the activities that would occur by the Industrial Receptor. Section 1.5 provides details on current and projected land use for this MRS.

2.1.1.3 Interaction

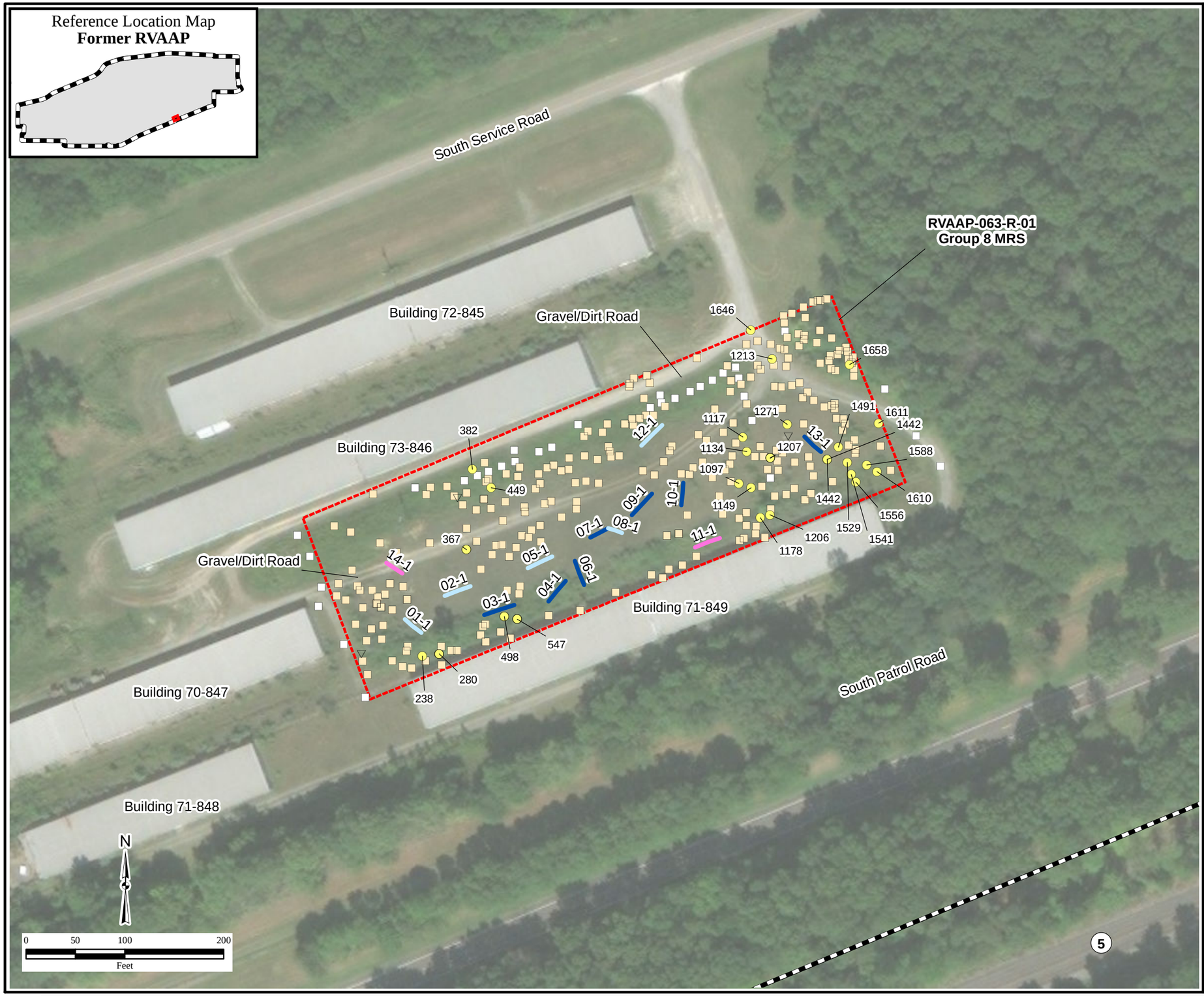
Interaction describes ways that receptors contact a source and includes both access and activity considerations. Activity describes ways that receptors come into contact with a source. Access describes the degree to which MEC is available to potential receptors. A receptor may contact MEC that is on the surface

by walking or handling if picked up. A receptor may contact MEC in the subsurface when performing intrusive activities. The location of Group 8 MRS is near existing buildings that are outside the MRS boundary. Current activities at the MRS include maintenance, natural resource management, environmental sampling activities, and use as access to adjacent buildings through the existing road network which primarily involve foot traffic only but may also include minimal intrusive activities. The future land use at the MRS and surrounding area is expected to remain the same with the potential for military training activities, summarized as Commercial/Industrial Land Use. Current activities at the Group 8 MRS include maintenance, natural resource management, sampling, and use as access to adjacent buildings through the existing road network. Future land use for this MRS is expected to include the current activities and potentially military training activities, summarized as Commercial/Industrial Land Use. The Industrial Receptor is the most representative of receptors that may also access the MRS as part of current land use activities. As stated in Section 1.5, the Industrial Receptor is the current receptor for this MRS, with a subsurface exposure depth defined as 4 feet bgs. Based on the theoretical future land uses which may include military training or residential land use, the theoretical future receptors include the National Guard Trainee and the Resident Receptor (Adult and Child).

2.1.1.4 MEC Exposure Conclusions

The MPPEH that was found during the RI was verified as MDAS by unexploded ordnance (UXO) qualified personnel. In the RI Report, the MDAS is discussed as munitions debris, or munitions debris (MD). Although MEC has been found on the ground surface (partially buried) and at a depth of 1-inch bgs, these items were not representative of munitions confirmed to be present at the MRS during the RI. Therefore, because no source of MEC is present, no interactions involving explosive hazards are expected to occur at the MRS. As a result, no explosive hazards at the Group 8 MRS are known to exist. Without a source of explosive hazards, the MEC exposure pathway is considered incomplete for all receptors. The updated MEC CSM for the Group 8 MRS is presented on Figure 2-1.

Based on the determination that historically identified MEC items are not representative of the overall contamination at the MRS, the MEC hazard analysis (HA) methodology was revisited. Due to the project team's determination that no explosive hazard exists at the Group 8 MRS a revised MEC HA was not warranted. The future land use at the MRS will be military training with the potential for intrusive activities. Based on further evaluation of the RI results following the conclusion of the RI, the MEC exposure pathway is considered incomplete due to the lack of a source at the Group 8 MRS.



HGL—Feasibility Study
Former RVAAP, Ohio

Figure 2-2
2015 Remedial Investigation Results
Group 8 MRS
Former RVAAP
Portage and Trumbull Counties, Ohio

Legend

Single Anomaly Results
- Control Point (QC)
- MDAS
- Other Debris
- Surface Metal

Trench Results
- MDAS Identified
- MDAS and Other Debris Identified
- Other Debris Identified

- MRS
- Installation Boundary

Notes:
MDAS=material documented as safe
MRS=munitions response site
QC=quality control
RVAAP=Ravenna Army Ammunition Plant

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Source: HGL, CB&I, USACE, e²M
ArcGIS Online Imagery

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2.1.2 MC Exposure Pathway Analysis

An exposure pathway is the course a chemical or physical agent takes from a source to a receptor. Each MC pathway includes a source, interaction (release mechanisms, exposure media, and exposure routes), and a receptor. The RI evaluated two receptors: Residential and National Guard Trainee. Since completion of the RI, the Industrial Receptor was identified as the Representative Receptor for this MRS (ARNG, 2014). The MC CSM was updated in this FS to incorporate this new receptor. The MC pathways identified for the MRS are described below.

2.1.2.1 Source

MC is defined as any material originating from UXO, discarded military munitions, or other military munitions including explosive and nonexplosive material, and emission degradation, or breakdown elements of such ordnance and munitions. An MC source exists where MC has entered (or may enter) the environment. MC contamination may result from a corrosion of munitions or from low-order detonations whereby unexpended filler material becomes exposed. Additionally, MC that is found at concentrations high enough to pose an explosive hazard is considered MEC. Although not documented, open burning of munitions may have occurred at the MRS, which may have resulted in MC contamination to the surrounding soil. In addition, corrosion of the buried MDAS found during the RI intrusive investigation activities may have released MC into the surrounding soil.

The medium receiving potential MC releases is soil; however, transport processes can move MC from one medium to another through leaching, runoff, and sorption. Sufficient time has elapsed for MC in the surface soil to have migrated to other media including surface water and sediment, resulting in possible exposure of plants, fish, and animals that encounter these media. However, except for a small drainage ditch along the south side of the MRS with fluctuating water levels, there are no significant surface water features where MC in surface soil could have migrated.

Soil data at the MRS was collected for MC during the RI. The data set consists of four surface soil incremental sampling methodology (ISM) samples (collected from 0 to 0.5 feet bgs) and three subsurface soil ISM samples (collected from 4 to 4.5 feet bgs) (Figure 2-3a). The ISM surface soil sampling units were created as four areas of equally probable anticipated use by potential receptors to evaluate the nature and extent of contamination associated with previous activities at the MRS. The surface soil sampling units were of four equal sizes to provide a representative comparison of various portions of the MRS. Three subsurface soil ISM samples were collected from 4 to 4.5 feet bgs at the bottoms of three trenches. The trenches were considered as separate sampling units. The sample units at the bottoms of the trenches made up the subsurface decision unit for the MRS (CB&I, 2015). Samples were analyzed for select metals, explosives, nitrocellulose, semivolatile organic compound (SVOCs), polychlorinated biphenyls (PCBs), total organic compound (TOC), and pH. Metals analysis included speciation for hexavalent chromium (Cr6+). Nitroguanidine and 2,4,6-trinitrotoluene were the only explosives detected. Polynuclear aromatic hydrocarbons (PAHs), bis(2-ethylhexyl)phthalate, dibenzofuran, di-n-butyl phthalate, Aroclor 1254, and Aroclor 1260 were also detected. Cr6+ was not detected, indicating that all chromium is in the trivalent form. Surface soil detections of antimony, barium, cadmium, chromium (trivalent), copper, iron, lead, mercury, strontium, and zinc exceeded the background screening values, indicating that these metals are site contaminants. In subsurface soil, detections of antimony, cadmium, copper, iron, lead, mercury, strontium, and zinc were identified as contaminants. The RI human health risk assessment concluded that detected

contaminants in surface soil presented potential risks to the Resident Receptor (Adult and Child) that is evaluated for Unrestricted (Residential) Land Use (UU/UE) and risks to the National Guard Trainee, the Representative Receptor for the future land use of military training. The RI ecological risk assessment concluded detected contaminants in surface soil had the potential for localized impacts to soil invertebrates and small range receptors. The RI Report concluded that no detected contaminants in subsurface soil were present at concentrations which pose a risk to receptors. A Risk Management Evaluation was prepared as part of this Feasibility Study and is presented in Section 2.1.2.4, below.

2.1.2.2 Receptors

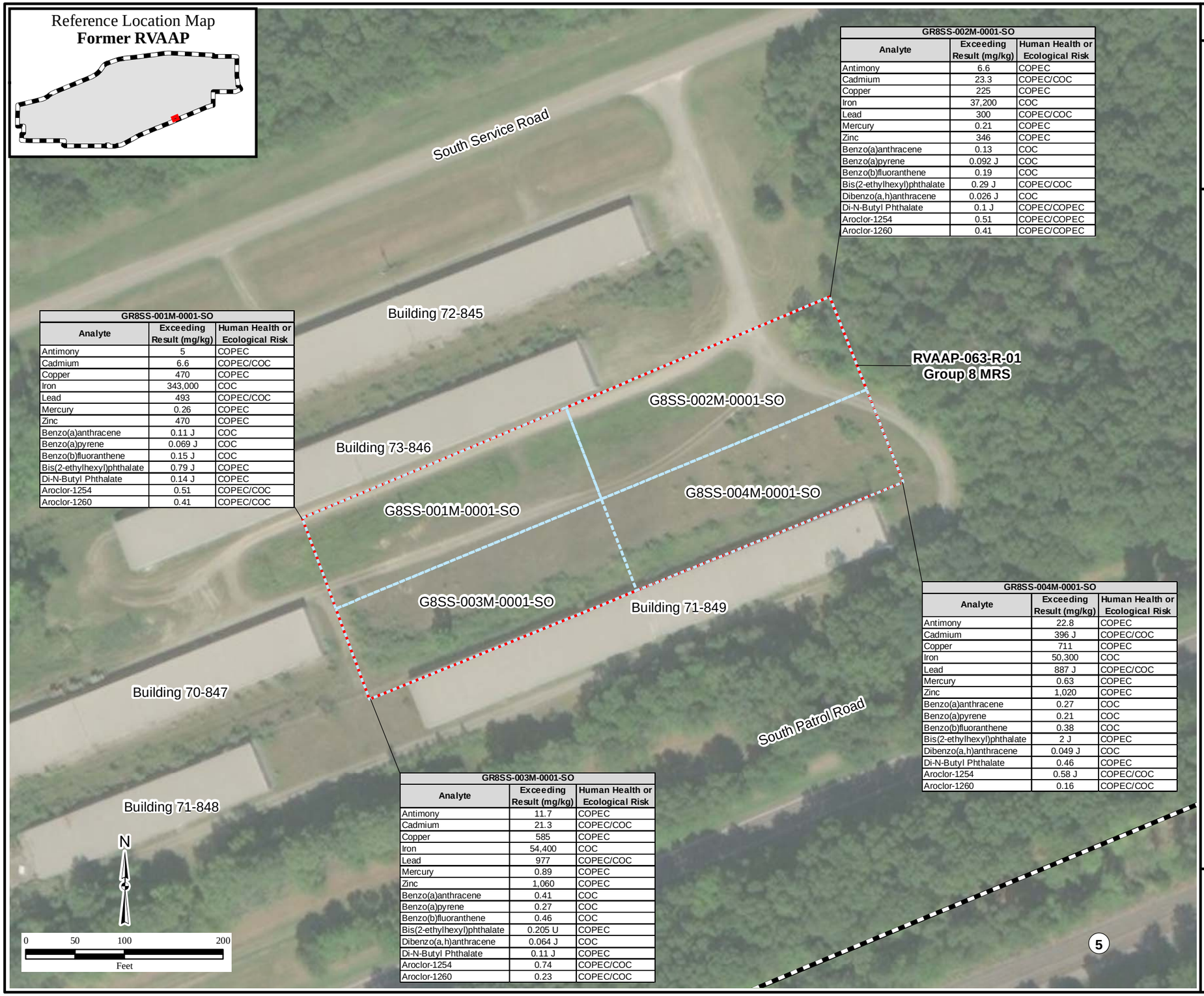
Current activities at the Group 8 MRS include, natural resource management, environmental sampling, and use as access to adjacent buildings through the existing road network. Based on these activities, land use at the Group 8 MRS is commercial/industrial. The human health risk assessment in the RI evaluated the potential risks to the National Guard Trainee and Resident Receptor (Adult and Child). Based on current land use, however, the most likely receptor is the Industrial Receptor. Because the Resident Receptor has a greater potential to experience an adverse effect than an Industrial Receptor, conditions protective of the Resident Receptor will also be protective of the Industrial Receptor and National Guard Trainee receptor.

Because of its small size, presence of roads and structures, lack of vegetation and other habitat features required by most organisms, and human presence, the Group 8 MRS represents a low-quality habitat for most ecological receptors other than ruderal plants and some small-range receptors (i.e., robins, mice, etc.). There are no populations of rare plants, animal species, wildlife resources, wetlands, or surface waters at the MRS.

2.1.2.3 Interaction

Interaction describes ways that receptors come into contact with a source, and includes release mechanisms, exposure media, and exposure pathways. The current Commercial/Industrial land use for this MRS is expected to continue into the foreseeable future. Exposure pathways identified for human interaction with MC contamination include potential exposure to surface and subsurface soil by direct contact, subsequent incidental ingestion and/or dermal absorption, and inhalation of dust particles.

The major exposure routes for chemical toxicity from surface soil to the environmental receptors include ingestion (for terrestrial invertebrates and upper trophic level receptors). Minor exposure routes for surface soil include dermal contact and inhalation of fugitive dust. With the exception of a small drainage ditch along the south side of the MRS, there are no significant surface water features where MC in surface soil could have migrated. Therefore, the MC exposure pathways for all receptors at the MRS to the aquatic environments, including surface water and sediment and accumulation into aquatic biota are considered incomplete.



GR8SS-001M-0001-SO		
Analyte	Exceeding Result (mg/kg)	Human Health or Ecological Risk
Antimony	5	COPEC
Cadmium	6.6	COPEC/COC
Copper	470	COPEC
Iron	343,000	COC
Lead	493	COPEC/COC
Mercury	0.26	COPEC
Zinc	470	COPEC
Benzo(a)anthracene	0.11 J	COC
Benzo(a)pyrene	0.069 J	COC
Benzo(b)fluoranthene	0.15 J	COC
Bis(2-ethylhexyl)phthalate	0.79 J	COPEC
Di-N-Butyl Phthalate	0.14 J	COPEC
Aroclor-1254	0.51	COPEC/COC
Aroclor-1260	0.41	COPEC/COC

GR8SS-002M-0001-SO		
Analyte	Exceeding Result (mg/kg)	Human Health or Ecological Risk
Antimony	6.6	COPEC
Cadmium	23.3	COPEC/COC
Copper	225	COPEC
Iron	37,200	COC
Lead	300	COPEC/COC
Mercury	0.21	COPEC
Zinc	346	COPEC
Benzo(a)anthracene	0.13	COC
Benzo(a)pyrene	0.092 J	COC
Benzo(b)fluoranthene	0.19	COC
Bis(2-ethylhexyl)phthalate	0.29 J	COPEC/COC
Dibenzo(a,h)anthracene	0.026 J	COC
Di-N-Butyl Phthalate	0.1 J	COPEC/COPEC
Aroclor-1254	0.51	COPEC/COPEC
Aroclor-1260	0.41	COPEC/COPEC

GR8SS-003M-0001-SO		
Analyte	Exceeding Result (mg/kg)	Human Health or Ecological Risk
Antimony	11.7	COPEC
Cadmium	21.3	COPEC/COC
Copper	585	COPEC
Iron	54,400	COC
Lead	977	COPEC/COC
Mercury	0.89	COPEC
Zinc	1,060	COPEC
Benzo(a)anthracene	0.41	COC
Benzo(a)pyrene	0.27	COC
Benzo(b)fluoranthene	0.46	COC
Bis(2-ethylhexyl)phthalate	0.205 U	COPEC
Dibenzo(a,h)anthracene	0.064 J	COC
Di-N-Butyl Phthalate	0.11 J	COPEC
Aroclor-1254	0.74	COPEC/COC
Aroclor-1260	0.23	COPEC/COC

GR8SS-004M-0001-SO		
Analyte	Exceeding Result (mg/kg)	Human Health or Ecological Risk
Antimony	22.8	COPEC
Cadmium	396 J	COPEC/COC
Copper	711	COPEC
Iron	50,300	COC
Lead	887 J	COPEC/COC
Mercury	0.63	COPEC
Zinc	1,020	COPEC
Benzo(a)anthracene	0.27	COC
Benzo(a)pyrene	0.21	COC
Benzo(b)fluoranthene	0.38	COC
Bis(2-ethylhexyl)phthalate	2 J	COPEC
Dibenzo(a,h)anthracene	0.049 J	COC
Di-N-Butyl Phthalate	0.46	COPEC
Aroclor-1254	0.58 J	COPEC/COC
Aroclor-1260	0.16	COPEC/COC

HGL—Feasibility Study
Former RVAAP, Ohio

Figure 2-3a
2015 Remedial Investigation
Delineated MC Contamination
Surface Soil Only
Former RVAAP
Portage and Trumbull Counties, Ohio

Legend

- Surface ISM Soil Sample Area
- MRS
- Installation Boundary

HHRA COCs - Surface Soil Only
Resident Receptor
Aroclor-1254
Aroclor-1260
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Cadmium
Dibenzo(a,h)anthracene
Iron
Lead
National Guard Trainee
Cadmium
Lead
ERA COPECs - Surface Soil Only
Antimony
Aroclor-1254
Aroclor-1260
Bis(2-ethylhexyl)phthalate
Cadmium
Copper
Di-N-Butyl Phthalate
Lead
Mercury
Zinc

Notes:
Surface soil defined as 0 ft bgs to 0.5 ft bgs.

COC=Chemical of Concern
COPEC=Chemical of Potential Ecological Concern
ERA=Ecological Risk Assessment
ft bgs=feet below ground surface
HHRA=Human Health Risk Assessment
ISM=incremental sampling method
J=estimated value
MC=munitions constituent
mg/kg=milligrams per kilogram
MRS=munitions response site
RVAAP=Ravenna Army Ammunition Plant
U=undetected

\\Gst-srv-01\HGLGIS\Ravenna_AAP\Group8\FS\(2-03a)Group8_SoilISMQuads.mxd
2/8/2019 TH
Source: HGL,CB&I, USACE, e²M
ArcGIS Online Imagery

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2.1.2.4 Risk Management Evaluation

The Human Health Risk Assessment (HHRA) completed as part of the RI Report evaluated potential risks to the National Guard Trainee and Resident Receptor (Adult and Child) who may be exposed to MC in the Group 8 MRS surface and subsurface soil (CB&I, 2015). The HHRA identified cadmium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, Aroclor-1254, and Aroclor-1260 in surface soil and iron in subsurface soil as COCs for the Resident Receptor (Adult and Child). Only two metals, cadmium and lead in surface soil, were identified as COCs for the National Guard Trainee.

Resident Receptor

Many exposure assumptions and toxicity values have changed since the development and publication of the Facility-Wide Human Health Cleanup Goals (FWCUGs) (SAIC, 2010). As agreed with the Ohio EPA, the U.S. Environmental Protection Agency (EPA) Regional Screening Levels (RSLs) can be used until the FWCUGs are updated to reflect current toxicity information and exposure assumptions. The EPA RSLs are updated every 6 months, and as shown previously, the EPA residential soil RSLs are protective of the Resident Receptor at CJAG. Since the 2015 RI only used the FWCUGs, this Risk Management Evaluation (RME) is being completed to re-assess the COCs using the RSLs to account for any changes in toxicity data and exposure assumptions. The contaminants of concern (COCs) identified for the Resident Receptor in the RI report were re-evaluated with respect to the current Residential Soil RSLs. This RME follows the streamlined Risk Assessment process developed for CJAG using the FWCUGs as outlined in the USACE 2012 Use and Application of FWCUGs. The Position Paper as well as the 2010 FWCUGs documents should be consulted for more details on the risk assessment process.

COCs based on Non-carcinogenic Effects

For non-carcinogenic effects, the maximum detection was divided by the RSL based on a hazard quotient (HQ) of 1. Four of the COCs listed in the RI report, cadmium, iron, benzo(a)pyrene, and aroclor 1254, have non-cancer toxicity values. Because these chemicals affect different target organs, their potential, non-cancer risks are not additive. The screening level calculations are shown in Table 2-2. The screening level HQs for iron in surface soil, iron in subsurface soil, benzo(a)pyrene, and aroclor 1254 are less than 1. These chemicals do not pose a non-cancer risk to future residents.

Table 2-2 COCs Based on Non-carcinogenic Effects

Analyte	Max detection (ppm)	Cancer RSL (ppm)	Screening Level Cancer Risk	Non-cancer RSL (ppm)	Screening Level Hazard Quotient	Target organ
Cadmium	396	2100	1.9E-07	71	5.6	kidneys
Iron, surface soil	54,400	--	--	55,000	0.99	Gastrointestinal Tract
Iron, subsurface soil	39,500	--	--	55,000	0.72	Gastrointestinal Tract
Benzo(a)anthracene	0.41	1.1	3.7E-07	--	--	
Benzo(a)pyrene	0.27	0.11	2.5E-06	18	0.015	Neurological/fetotoxicity
Benzo(b)fluoranthene	0.46	1.1	4.2E-07	--	--	
Dibenzo(a,h)anthracene	0.064	0.11	5.8E-07	--	--	
Aroclor 1254	0.74	0.24	3.1E-06	1.2	0.62	eyes, immune system, nails
Aroclor 1260	0.41	0.24	1.7E-06	--	--	
		Total	8.8E-06			

ppm denotes parts per million

The screening level HQ for cadmium is 5.6. Cadmium was detected in each of the four surface soil ISM samples collected during the RI. The detections are:

- GR8SS-001M-0001-SO: 6.6 milligrams per kilogram (mg/kg)
- GR8SS-002M-0001-SO: 23.3 mg/kg
- GR8SS-003M-0001-SO: 21.3 mg/kg
- GR8SS-004M-0001-SO: 396 mg/kg

Three of the four cadmium concentrations are less than the Residential RSL for soil of 71 mg/kg. The only sampling unit where cadmium could pose a risk to a future resident is GR8SS-004M. If the cadmium-contaminated soil in GR8SS-004M is excavated, cadmium at the site will not pose a health risk. This approach of truncating the dataset to identify the area(s) that requires remediation to achieve Unrestricted (Residential) Land Use is called "hill-topping."

COCs based on Carcinogenic Effects

To calculate screening level cancer risks, the maximum detection was divided by the Residential Soil RSL based on cancer effects and the quotient was multiplied by 1E-06. The screening level risks for each COC were summed to calculate a cumulative, screening level risk. This cumulative risk is 8.8E-06, which is less than the target value of 1E-05 for identifying cancer COCs (*Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant (RVAAP) Installation Restoration Program*, [ARNG, 2014]). No COCs are identified for the Resident Receptor on the basis of potential cancer risks.

Exposure to Lead

Potential risks from exposure to lead are evaluated by comparing concentrations to the health-based screening value of 400 mg/kg. The lead result for GR8SS-002M-0001-SO of 300 mg/kg is less than this screening value. The lead concentration for the other three ISM samples ranges from 493 mg/kg to 977 mg/kg. If sampling unit GR8SS-004M is excavated to remediate the cadmium-contaminated soil as described above, the average lead concentration for the soil remaining on site will be 590 mg/kg, which is less than 1.5 times the screening value. Based on the low ratio by which the screening value is exceeded, remaining lead in soil should not pose a risk under an Unrestricted (Residential) Land Use (UU/UE).

In summary, remediating GR8SS-004M should support closure with unrestricted (resident) land use for the remainder of the site.

National Guard Trainee and Industrial Receptor

The HHRA completed as part of the RI Report evaluated potential risks to the National Guard Trainee who may be exposed to MC in the Group 8 MRS surface and subsurface soil (CB&I, 2015). The RI report identified cadmium and lead as COCs for the National Guard Trainee. Per the 2014 Final Technical Memorandum (ARNG, 2014), conditions that achieve Unrestricted (Residential) Land Use are protective of other potential land uses, including military training. For this reason, "hill-topping" the dataset by remediating GR8SS-004M will be protective of the National Guard trainee and the Industrial Receptor and will eliminate cadmium as a COC.

Ecological Receptors

The soil contaminants listed below were identified in the Final RI Report for RVAAP-063-R-01 Group 8 MRS as ecological risk drivers (CB&I, 2015). These COCs were identified by food web modeling that indicated the potential for risks to upper trophic level receptors.

- Antimony (insectivorous mammals)
- Cadmium (insectivorous mammals and birds)
- Copper (insectivorous mammals and birds)
- Lead (insectivorous mammals and birds)
- Zinc (insectivorous mammals and birds)
- bis(2-Ethylhexyl) Phthalate (insectivorous birds)
- di-n-Butyl Phthalate (insectivorous birds)
- Aroclor-1254 (insectivorous mammals and birds)
- Aroclor-1260 (insectivorous mammals and birds)

For several reasons, the ecological risk assessment included in the RI report is overly conservative. First, habitat quality is poor. As shown in the aerial photograph on Figure 2-3b, the site is surrounded by buildings and roads and a gravel road cuts through the middle of the site. Where there is no gravel, vegetation consists of mowed grass and ruderal plants. The buildings are used for storage and vehicles traverse the site to access the buildings. These conditions are not conducive to foraging by birds and mammals. Second, for the short-tailed shrew, which is the species used to represent insectivorous mammals, the ecological risk assessment used a food ingestion rate of 0.56 kilogram food dry weight per kilogram body weight per day (kg-dw/kg-day) and a soil ingestion rate equal to 13% of the dry food ingestion rate. EPA's Ecological Soil Screening Levels for insectivorous mammals, which were developed by EPA to provide conservative screening values, are based on a food ingestion rate of 0.209 kg-dw/kg-day and soil ingestion rate that is

only 3 percent of the food ingestion rate (EPA, 2007). Based on current guidance, the food and soil ingestion rates used in the ecological risk assessment substantially overestimate potential exposure by insectivorous mammals. Finally, the RI report acknowledges that the potential for adverse effects to the ecological communities is likely overestimated. Given the conservatism of the analysis, the poor habitat quality at the site, and the relatively small area spanned by the site, it is unlikely that site contaminants pose a risk to wildlife communities.

2.1.2.5 MC Exposure Conclusions

Based on the risk management evaluation, it is concluded that cadmium in surface soil at GR8SS-004M-0001-SO poses a risk to the future Resident Receptor (Adult and Child). Soil contaminants do not pose a risk to the Industrial Receptor, who is the representative receptor under current site use. Remediation of the cadmium contamination in GR8SS-004M (Figure 2-3b) will eliminate potential risks to human health under Unrestricted (Residential) Land Use.

2.2 Problem Identification

There is no MEC hazard present at the MRS (MDAS only was identified during the RI). The HHRA and the ecological risk assessment conducted during the RI identified the potential for cadmium in site soil to pose a risk to the theoretical future Resident Receptor at GR8SS-004M-0001-SO, only. The EPA residential soil RSL of 71 mg/kg is identified as the preliminary remediation goal (PRG) for cadmium in surface soil.

*2.3 Preliminary Identification of Applicable or Relevant and Appropriate Requirements **and "To Be Considered" Information***

Under Section 121 (d)(2)(A) of CERCLA, remedial actions must meet a level and standard of control that attain standards, requirements, limitations, or criteria that are "applicable or relevant and appropriate" under the circumstances of the release. These requirements are derived from federal and state laws and are known as ARARs. Federal, state, or local permits are not necessary for removal or remedial actions implemented under a CERCLA remedial action, but applicable substantive requirements or ARARs must be met.

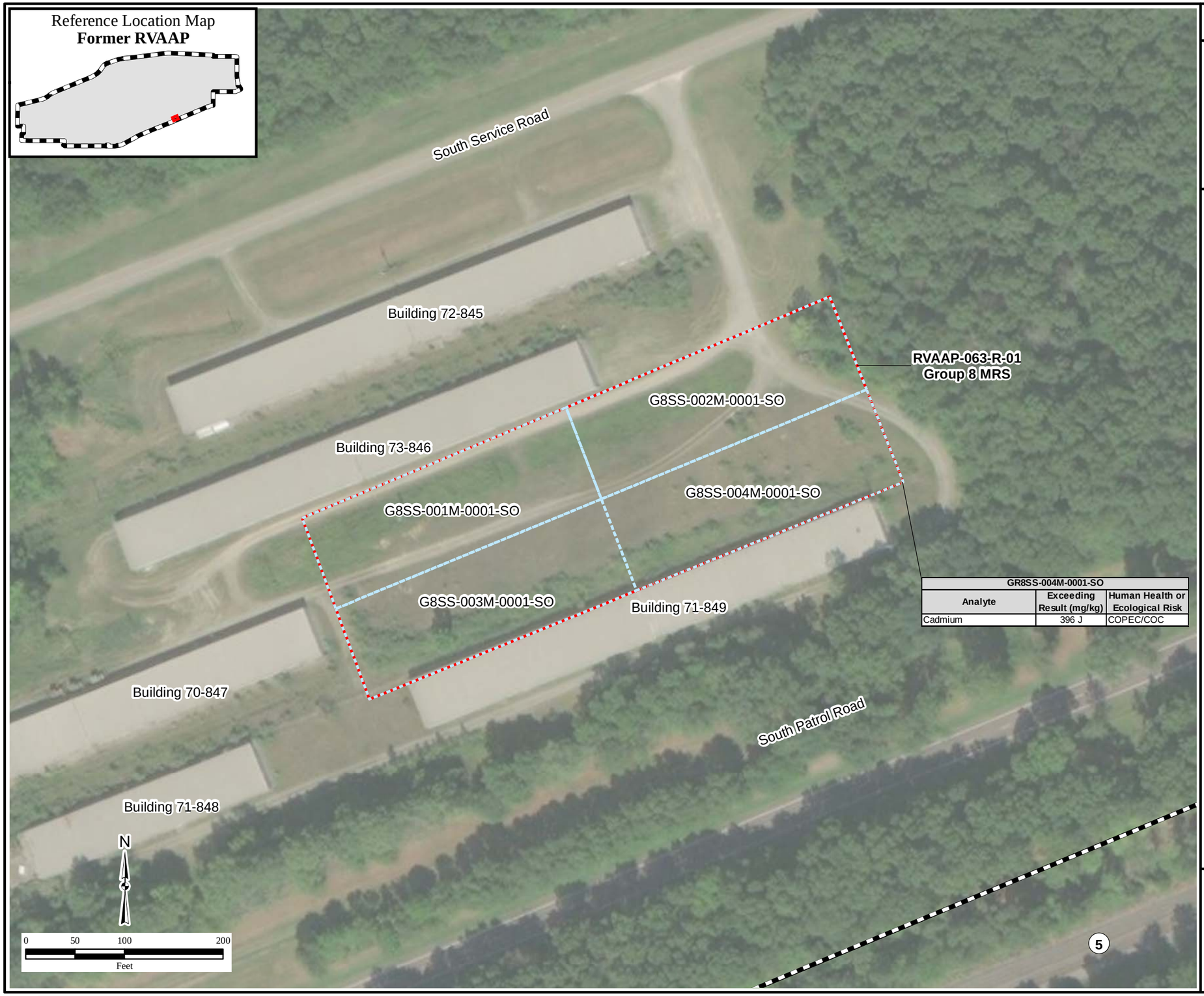
The NCP (40 CFR 300.5) defines "applicable requirements" as follows:

> …those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

The NCP (40 CFR 300.5) defines "relevant and appropriate requirements" as

> …those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

In addition to legally binding laws and regulations, many federal and state environmental public health programs also develop criteria, advisories, guidance, and proposed standards that are not legally binding but may provide useful information or recommended procedures. These to be considered (TBC) requirements are not promulgated and, thus, are not potential ARARs. State requirements identified in a timely manner



HGL—Feasibility Study
Former RVAAP, Ohio

Figure 2-3b
2019 Feasibility Study
Risk Management Evaluation
Delineated MC Contamination
Former RVAAP
Portage and Trumbull Counties, Ohio

Legend

- Surface ISM Soil Sample Area
- MRS
- Installation Boundary

HHRA COCs - Surface Soil Only
Resident Receptor
Aroclor-1254
Aroclor-1260
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Cadmium
Dibenzo(a,h)anthracene
Iron
Lead
National Guard Trainee
Cadmium
Lead
ERA COPECs - Surface Soil Only
Antimony
Aroclor-1254
Aroclor-1260
Bis(2-ethylhexyl)phthalate
Cadmium
Copper
Di-N-Butyl Phthalate
Lead
Mercury
Zinc
No habitat present onsite

Notes:
Surface soil defined as 0 ft bgs to 0.5 ft bgs.

COC=Chemical of Concern
COPEC=Chemical of Potential Ecological Concern
ERA=Ecological Risk Assessment
ft bgs=feet below ground surface
HHRA=Human Health Risk Assessment
ISM=incremental sampling method
J=estimated value
MC=munitions constituent
mg/kg=milligrams per kilogram
MRS=munitions response site
RVAAP=Ravenna Army Ammunition Plant

\\Gst-srv-01\HGLGIS\Ravenna_AAP\Group8\FS
(2-03b)Group8_Delineated_MC.mxd
2/8/2019 TH
Source: HGL,CB&I, USACE, e²M
ArcGIS Online Imagery

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that are more stringent than corresponding federal requirements may be applicable or relevant and appropriate.

In addition to legally binding laws and regulations, many federal and state environmental public health programs also develop criteria, advisories, guidance, and proposed standards that are not legally binding but may provide useful information or recommended procedures. These TBC requirements are not promulgated and, thus, are not potential ARARs. State requirements identified in a timely manner and that are more stringent than corresponding federal requirements may be applicable or relevant and appropriate. The EPA classifies ARARs as chemical-, action-, and location-specific to provide guidance for identifying and complying with ARARs (EPA, 1988). All ARARs must meet the following criteria:

- Are limited to promulgated requirements;
- Are environmental or facility siting laws;
- Are substantive requirements; and
- Pertain to the circumstances at the MRS.

2.3.1 Chemical-Specific ARARs and TBCs

Chemical-specific ARARs are health- and risk-based numerical values and methodologies that, when applied to MRS-specific conditions, result in the establishment of numerical values. These values and methodologies (such as promulgated standards and risk assessments, respectively) establish acceptable concentrations of a chemical contaminant that may remain in the environment. Chemical-specific TBCs may be used in the absence of chemical-specific ARARs or where chemical-specific ARARs are not sufficiently protective to develop remediation goals.

The Toxic Substances Control Act (TSCA), implemented through 40 CFR 761, authorizes the Federal government to regulate the manufacture, use, storage, and disposal of hazard chemicals including PCBs. PCBs in site soil meet the definition of a PCB remediation waste (40 CFR 761.3), listed below. The PCB source is not known, but it is unlikely to have been a use authorized under 40 CFR 761.30.

> *"PCB remediation waste* means waste containing PCBs as a result of a spill, release, or other unauthorized disposal, at the following concentrations: Materials disposed of prior to April 18, 1978, that are currently at concentrations ≥50 ppm PCBs, regardless of the concentration of the original spill; materials which are currently at any volume or concentration where the original source was ≥500 ppm PCBs beginning on April 18, 1978, or ≥50 ppm PCBs beginning on July 2, 1979; and materials which are currently at any concentration if the PCBs are spilled or released from a source not authorized for use under this part."

Remediation of PCB waste is described in 40 CFR 761.61. All detections reported for site soil are less than the most stringent cleanup standard identified in 40 CFR 761.61, which is 1 mg/kg for high occupancy areas. Because site concentrations are less than the cleanup standard, the substantive requirements of 40 CFR 761 are not directly applicable, but are relevant and appropriate. TSCA is identified as a chemical-specific ARAR. EPA RSLs (EPA, 2016) and FWCUGs (SAIC, 2010) are non-promulgated risk-based levels developed to protect human and ecological receptors. In the absence of chemical-specific ARARs for the MRS, these RSLs and FWCUGs are considered TBCs for the MRS and are used to develop MRS-specific PRGs for the MC COCs. These TBCs are listed in Table 2-3 below.

2.3.2 Location-Specific ARARs

Location-specific ARARs govern activities in certain environmentally sensitive areas. These requirements are triggered by the particular location and the proposed activities at the MRS. There are no federal-listed species or critical habitats at the Group 8 MRS based on the updated *Integrated Natural Resources Management Plan (INRMP)* (OHARNG, 2014). The Northern long-eared bat is a federally threatened species that is now listed for the facility. There are vegetation cutting restrictions in place for the facility during the Northern long-eared bat summer roosting season, which is between April 1 and September 30. The Group 8 MRS is unimproved grassy land and gravel roads, surrounded by existing buildings. The MRS is described in the INRMP as "semi-improved grounds", which are areas that receive periodic maintenance. The MRS is mowed at least once per year. Herbicide is applied to control weeds at the existing buildings near the MRS, the roads within the MRS, and in the existing ditch within the MRS. Biological inventories have not been completed specifically for this MRS, and no confirmed sightings of state-listed species have been reported. There is a low likelihood for state-listed or rare species to be present within the boundaries of the MRS due to the lack of habitat. Any vegetation clearance necessary to remove MC-contaminated soil from the MRS, therefore, would not affect any critical habitat or endangered species. In addition, there are no wetlands at the MRS. Therefore, there no location-specific ARARs are identified for the MRS.

2.3.3 Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements or limitations on actions to be taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities selected to accomplish a remedy. Under 40 CFR 122.44(s)(1), EPA delegates authority of erosion and sediment control programs to qualifying state, tribal, or local programs. The Ohio EPA has authority to administer these programs and provides additional details in Ohio Administrative Code (OAC) 1501.15 to the federal regulations outlined in 40 CFR 122. The Ohio Erosion and Sediment Control Regulations establish the State of Ohio standards to achieve a level of management and conservation practices that will control wind or water erosion of the soil and minimize the degradation of water resources by soil sediment in conjunction with land grading, excavating, filling, or other soil-disturbing activities The state standards are designed to implement applicable water quality management and nonpoint source management plans prepared under Section 208 and Section 319 of the Federal Water Pollution Control Act. The erosion and sediment control regulations apply to development for non-farm commercial, industrial, residential, or other non-farm purposes and are not directly applicable to remedial actions in the MRS but may be relevant and appropriate. The requirements in OAC 1501:15-1-03 through OAC 1501:15-1-05 appear to be the only substantive requirements contained in OAC 1501.15. The substantive requirements in OAC 1501:15-1-03 and OAC 501:15-1-05 would apply for disturbance of one acre or more. Because any MC-contaminated soil removal would disturb an area of 0.66 acres, the substantive requirements in OAC 1501:15-1-03 and OAC 501:15-1-05 are not considered relevant and appropriate for the MRS. The MRS is 2.67 acres in size and the MC-contaminated surface soil area is 0.66 acres in size. Specific requirements under OAC 1501.15-1-04 include the implementation of controls to minimize erosion and prevent sediment from migrating off of the MRS throughout all earth-disturbing activities. These requirements are relevant and appropriate if an area equal to or greater than 1 acre is disturbed during MC-contaminated soil removal. Action-specific ARARs for the Group 8 MRS are presented in Table 2-3 below.

Table 2-3 Group 8 MRS TBCs and ARARs

Requirement	Citation(s)	Description	Applicable	Relevant and Appropriate	Comments
Chemical-Specific ARARs and TBCs					
TSCA	40 CFR 761.61,	Describes the cleanup and disposal of remediation waste.	No: PCB concentrations are less than the most stringent cleanup standard.	Yes: Describes remediation and disposal procedures for PCB remediation waste.	Site concentrations are less than the cleanup standard for high occupancy areas.
EPA RSL	EPA, May 2013	Provides industrial and residential risk-based screening levels for soil.	TBC: RSLs provide concentrations protective of human health that can be used as PRGs.		
FWCUG for Ravenna Army Ammunition Plant	SAIC, 2010	Provides residential risk-based screening levels for soil.	TBC: FWCUGs can be used as PRGs protective of human health under an unrestricted use/unrestricted exposure scenario.		
Location-Specific ARARs					
None					
Action-Specific ARARs					
Erosion and Sediment Control Regulations	OAC 1501.15-1-04	These rules require that sediment and erosion controls be employed in areas of denudation and land disturbance, and describe management and conservation practices that will control wind or water erosion of the soil and minimize the degradation of water resources by soil and sediment	No. The MRS is not being developed for non-farm commercial, industrial, residential, or other non-farm purposes	Yes. Excavation and removal of MC-contaminated soil does disturb the land surface and may contribute to erosion and sedimentation.	May be relevant and appropriate to any alternatives involving the removal of MC contamination that disturbs the soil and contributes to erosion and sedimentation.

ARAR denotes applicable or relevant and appropriate requirement.
CFR denotes Code of Federal Regulations.
EPA denotes U.S. Environmental Protection Agency
FWCUG denotes Facility-Wide Human Health Cleanup Goals
MC denotes munitions constituent.
MRS denotes munitions response site.
OAC denotes Ohio Administrative Code.
PCB denotes polychlorinated biphenyl.
RSL denotes Regional Screening Level
SAIC denotes Science Applications International Corporation.
TBC denotes to be considered.
TSCA denotes Toxic Substances Control Act.

2.4 Remedial Action Objectives and Preliminary Remedial Goals

RAOs are developed to determine the effectiveness of the remedial action based on the CSM for the MRS and are focused on limiting or removing exposure pathways for MC (U.S. Army, 2009). RAOs specify the contaminant(s) and media of concern, potential exposure pathways, and remediation goals (40 CFR 300.430I(2)(i)). The RAOs for the MRS address the overall goals of managing the potential risk from MC in surface soil to protect human and ecological receptors from these hazards. This FS addresses the risks to human and ecological receptors from MC contamination in soil. As summarized in Section 2.1.2, Cadmium in surface soil was identified as a COC for the potential future Resident Receptor (Adult and Child). For purposes of evaluating a remedial alternative that will achieve unlimited use/unrestricted exposure (UU/UE) conditions on the MRS, the risks to the Resident Receptor are evaluated. The medium of concern is soil between ground surface to 0.5 bgs, which encompasses the surface soil impacted by MC contamination at GR8-SS-004M. Surface soil only is impacted by MC contamination to a maximum depth of 0.5 foot. The following RAOs were developed for the Group 8 MRS:

Prevent exposure of a Resident Receptor (Child and Adult) to cadmium present in surface soil (0 to 0.5 ft bgs) at GR8SS-004M (see Section 2.4.1).

The EPA residential soil RSL of 71 mg/kg is identified as the PRG for cadmium in surface soil. This will be protective of the current receptors by accomplishing remediation for the Resident Receptor (Adult and Child) under the theoretical future Unrestricted (Residential) Land Use.

The technologies and process options developed to support GRAs to attain the RAOs are presented in Section 3.0 and alternatives are screened in Section 4.0.

2.4.1 Summary of Extent of MC contamination in Soil

The quantity of MC contaminated soil is estimated based on the RI Report conclusions and the Risk Management Evaluation presented in Section 2.1.2.4. Collection of laboratory analytical samples are included in the cost estimate (Appendix B) to confirm the extent of impacted soil that exceed PRGs is excavated. The area of potential MC-contaminated soil is estimated to be 0.66-acre ISM sampling unit GR8SS-004M within Group 8 MRS and will be based on the analytical data to be collected in confirmation samples. For cost estimating purposes, the total amount of soils requiring excavation is estimated to be the 0.66 acres excavated to an average 0.5-ft bgs for a total of 533 cubic yards (CYs) of soil that will require stockpiling and management on site. It is assumed that the entire 533 CYs of stockpiled soils will not meet the analytical requirements for use as backfill on the MRS. Therefore, it is estimated that 533 CYs will require offsite disposal as non-hazardous waste. Therefore, transport and disposal costs are included in the Appendix B cost estimates for a subcontractor and the appropriate offsite landfill facility disposal fees, for the quantities established.

2.5 Summary of Institutional Analysis

The IA was prepared to support the development and initial screening of LUCs. LUCs protect property owners and other workers or personnel from potential hazards by warning them of their existence and/or limiting access to, or use of, the MRS. LUCs can include legal mechanisms, engineering controls, and educational controls. However, the effectiveness of LUCs depends on the support, involvement, and willingness of local

agencies, stakeholders, and landowners to enforce and maintain them. Further, not all LUCs are appropriate for implementation at the facility. The LUCs that were retained for evaluation in the screening process following the IA are presented in Section 3.2.2. The IA is presented in Appendix A.

The institutions identified and analyzed in the IA that have jurisdiction or authority at the MRS include the USP&FO for Ohio, OHARNG, ARNG, the Ohio EPA, and USACE. The IA establishes that the ARNG has the financial capability to establish, implement, and maintain LUCs at the MRS. The ARNG coordinates that implementation with OHARNG. The OHARNG has the willingness and authority to implement LUCs, should they be identified as the chosen alternative.

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3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Development of remedial alternatives begins with identifying applicable remedial technologies. This section identifies and screens remedial technologies that are applicable to address risks posed by MC contamination at the Group 8 MRS in accordance with EPA guidance (EPA, 1988), the NCP (EPA, 1990), and the *Final United States Army Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009).

The primary objective of identifying, screening, and evaluating potentially applicable technology types and process options for the Group 8 MRS is to identify an appropriate range of remedial technologies and process options to be developed into remediation alternatives. The *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA, 1988) established a structured process for this purpose. A series of steps is used to reduce the identified potential remedial options to a smaller group of viable ones, from which remedial alternatives are developed. This series of steps is as follows:

- Identify the MRS volume of soil containing MC based on the RAOs;
- Identify GRAs to achieve the RAO; and
- Identify technologies and process options based on the GRA options, which are then screened based on effectiveness, implementability, and cost.

3.1 General Response Actions

GRAs are those actions that will achieve the RAOs and may include detection, removal, and disposal of MC contaminated soils; LUCs; or combinations of these actions. Under CERCLA, evaluation of a No Action alternative is required, pursuant to the NCP (40 CFR 300.430 et seq.), to provide a baseline for the other remedial technologies and alternatives. No action refers to an MRS remedy under which no active remediation or enforceable LUCs are implemented. The DERP manual (DoD, 2012) requires the DoD Component to include at least three alternatives, including no action, an action to remediate to UU/UE, and an action to remediate an MRS to a protective condition that uses LUCs. The following GRAs have been identified and considered for the Group 8 MRS:

- No Action: As stated above, the No Action alternative provides a baseline response for comparison to other remedial response actions.
- LUCs: This GRA includes physical, legal, and administrative mechanisms used to mitigate the chemical hazards associated with the MC contaminated soil present on the MRS. The development and screening of LUCs for this MRS are presented in the IS (Appendix A). The LUCs retained from initial screening in the IA are evaluated in the FS.
- MC Containment: Containment technologies include methods to reduce receptor access to contaminated soils. These technologies do not address volume and toxicity.
- MC Treatment: Treatment technologies include methods to reduce concentrations of MC or make them less leachable or bioavailable. Metals cannot be destroyed, so treatment does not include destruction.

- MC Removal: Removal technologies address MC contamination at the site by removing the media containing the metals. Removal can mitigate exposure pathways; however, it has no effect on the toxicity or volume of contaminated material. Removal is always used in conjunction with disposal and often with treatment.

Except for the No Action alternative, the GRAs identified above may be combined to develop remedial action alternatives for the Group 8 MRS. Section 3.2 below provides further discussion of GRAs and the technologies that comprise them.

3.2 Remedial Technologies and Process Options

This section documents the identification and screening of remedial technology types and process options applicable to each GRA. Technology types and process options retained from the identification and screening step will be used to formulate remedial alternatives discussed in subsequent sections of this FS. Remedial alternatives are developed by assembling combinations of applicable technologies and other unit processes into a sequence of actions that address the specific media to which they would be applied and the RAOs that were developed for the MRS. Accordingly, the identification and screening of remedial technology types and process options is a necessary and important first step in the development of remedial alternatives. The matrix of process options developed in this section is not intended to comprise the universe of all processes that exist; it is intended as a broad spectrum of potentially applicable process options considering MRS conditions and the CSM. Additionally, a Five-Year Review process is required for any alternative that would leave residual hazards at the MRS. Five-Year Reviews provide an opportunity to evaluate the implementation and performance of a remedy to determine whether it remains protective of human health and the environment.

The evaluation of remedial technology types and process options is a two-step process. The first step is an initial screening of technologies and process options. This is generally done on the basis of technical implementability in order to eliminate process options or entire technology types that would clearly be ineffective or unworkable considering the MRS conditions and MC hazards. The types and concentrations of MC can also influence the selection of suitable technologies. Typically, this screening step is MRS-specific; however, other factors may also need to be considered. Figure 3-1 presents preliminary identification and screening of remedial technologies and process options. Those that are not technically feasible at the MRS are immediately screened out of further consideration, as shown in Figure 3-1.

FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS RVAAP-063-R-01 GROUP 8 MRS

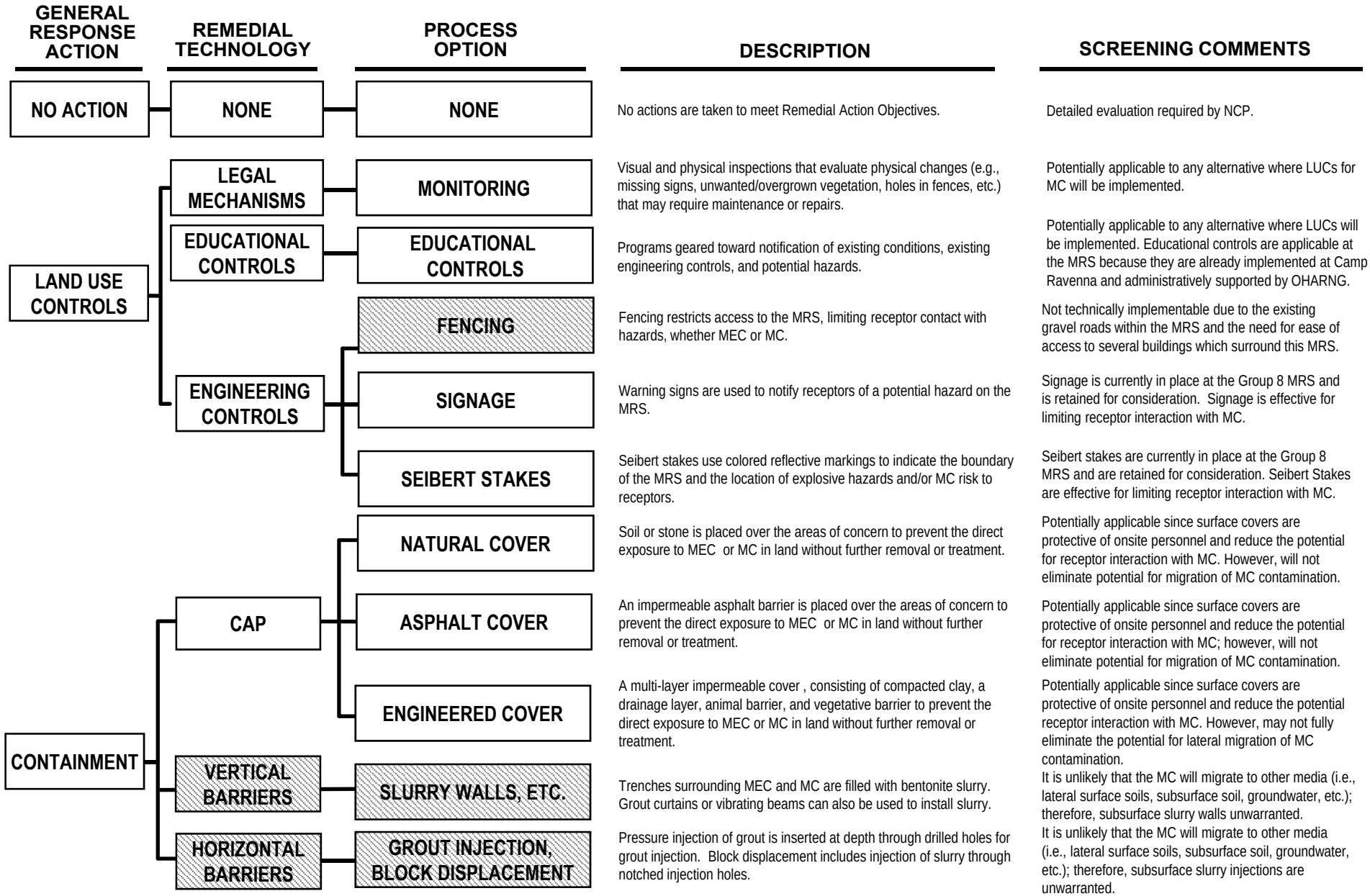

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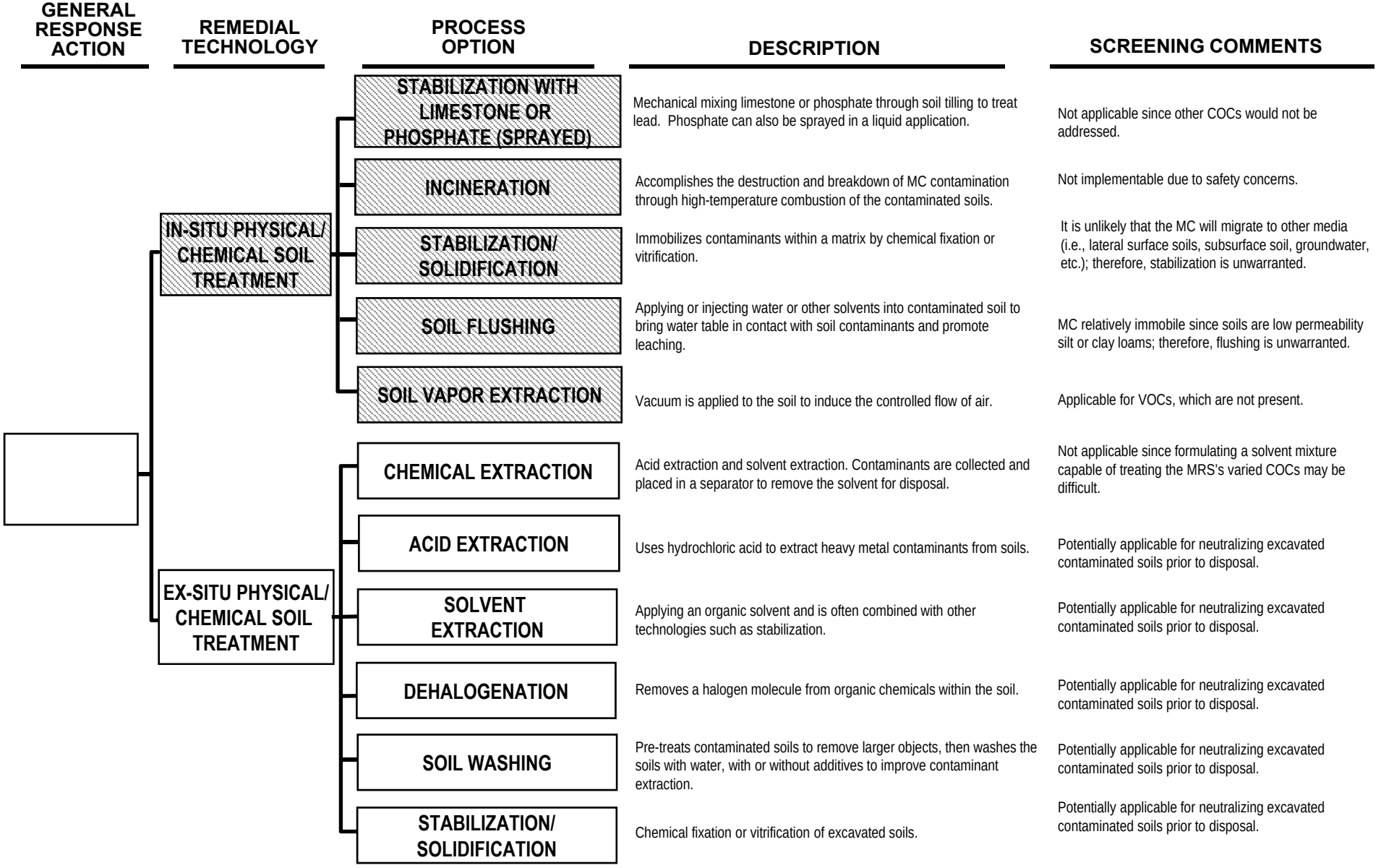
FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS RVAAP-063-R-01 GROUP 8 MRS



Eliminated from further consideration *Retained for further consideration*

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FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS RVAAP-063-R-01 GROUP 8 MRS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
SOIL TREATMENT CONTINUED	EX-SITU PHYSICAL/ CHEMICAL SOIL TREATMENT CONTINUED	STABILIZATION/ SOLIDIFICATION by VITRIFICATION	Vitrification of excavated soils. Vitrification creates a glass-like solid that entraps contamination thereby isolating it from the environment. High temperatures are required to melt soil.	Potentially applicable for neutralizing excavated contaminated soils prior to disposal.
SOIL TREATMENT (CONTINUED)	BIOREMEDIATION OF SOILS	PHYTOREMEDIATION/ EXTRACTION	Uses the uptake of contaminants by plants and stored in their roots, stems, and/or leaves.	Not applicable since limited to the root depth of the plants. Contaminants located below the reach of the root zone would have to be overturned to achieve root access or excavated.
		RHIZOSPHERE DEGRADATION AND PHYTOSQUESTRATION	Destroys or sequesters contaminants in-situ using crops through the interaction of the plant and microbial communities within the root zone.	Not applicable since limited to the root depth of the plants. Contaminants located below the reach of the root zone would have to be overturned to achieve root access or excavated.
		ENHANCED BIOREMEDATION	Uses contaminants as a food or energy source to destroy or transform or contaminants, including slurry-phase, solid phase, and anaerobic biodegradation.	Not applicable since does not treat inorganic contaminants. Difficult to distribute amendments through vadose zone soil and maintain sufficient water content for the biological reactions to occur.
		MONITORED NATURAL ATTENUATION	Relies on natural processes to reduce the contaminant concentration over time through biodegradation, dilution, sorption, evaporation, and chemical reactions.	Not applicable since limited effectiveness for SVOCs and inorganic contaminants.
MC SOIL REMOVAL	EXCAVATION	HEAVY EQUIPMENT	Excavation of contaminated soil using heavy equipment such as dozers and excavators.	Potentially applicable to remove contaminated soil. Ancillary construction activities may be necessary such as soil erosion control, excavation dewatering, water treatment, dust control, and vegetation clearing.
WASTE DISPOSAL	ON-SITE DISPOSAL	ON-SITE DISPOSAL FACILITY	On-site disposal of soils in an engineered structure that physically separates impacted materials from potential receptors.	Not applicable since the design and construction of a new disposal facility onsite would impact the current access to the surrounding buildings and driveways.
	OFF-SITE DISPOSAL	OFF-SITE DISPOSAL FACILITY	Off-site disposal in a permitted or licensed facility such as a regulated landfill.	Potentially applicable based on previous disposal activities at RVAAP.

Eliminated from further consideration *Retained for further consideration*

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The second step in this process is to evaluate the process options considered to be technically implementable in greater detail in order to select the representative process for each technology type. The evaluation of process options is generally based on the three criteria of: 1) effectiveness, 2) implementability; and 3) cost. Although these are the same criteria used to screen remedial alternatives prior to detailed analysis, at this stage, these criteria are applied only to technologies and process options and not to MRS-wide alternatives. In addition, the evaluation of process options focuses more on assessing effectiveness and less on implementability and cost. The evaluation measurements for the three criteria are presented in further detail as follows:

- Effectiveness: The technologies processes that are identified will be evaluated further on their effectiveness relative to the other processes within the same technology types. The evaluation for effectiveness will focus on: 1) the potential effectiveness of the process options in handling the residual MC contaminated soils and meeting the RAOs; 2) the potential effects on human health and the environment during implementation; and 3) how proven and reliable the process option is with respect to addressing residual MC contaminated soils and the conditions at the MRS (EPA, 1988).
- Implementability: Implementability is the ability of the technology to be implemented at the MRS. Implementability consists of both technical and administrative feasibility. Technical feasibility considerations may include the availability of necessary services, equipment, and skilled workers to implement a remedial technology. Administrative implementability considerations include the ability to obtain necessary permits for offsite actions as well as the availability of treatment, storage, and disposal services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology (EPA, 1988).
- Cost: The relative cost with respect to both capital and operation and maintenance (O&M) requirements. Costs are estimated on the basis of engineering judgment. An option is evaluated as to whether its costs are high, low, or moderate relative to other options within the same technology type. If two options are determined to provide equal benefits with regards to effectiveness and implementability, the higher cost option is eliminated from further analysis (EPA, 1988).

Figure 3-2 further screens the identified technologies on the three criteria. Technologies and process options that are retained are incorporated in alternatives developed in Section 4.0.

3.2.1 No Action

There are no remedial technologies or process options for the No Action GRA. This GRA is retained for detailed evaluation as required by the NCP.

3.2.2 Land Use Controls

Under the MMRP, LUCs are used in CERCLA remedies to restrict or control exposures of potential receptors to MC contamination that may remain in place at the site "…to assure continued effectiveness of the response action" (40 CFR 300.430 [e][3][ii]). LUCs consist of various legal mechanisms and engineering and educational controls that minimize the potential for risk to human receptors at an MRS with known MC contamination. Instead of direct elimination of MC contamination, LUCs rely on behavior modification and/or access control strategies to reduce or eliminate risk.

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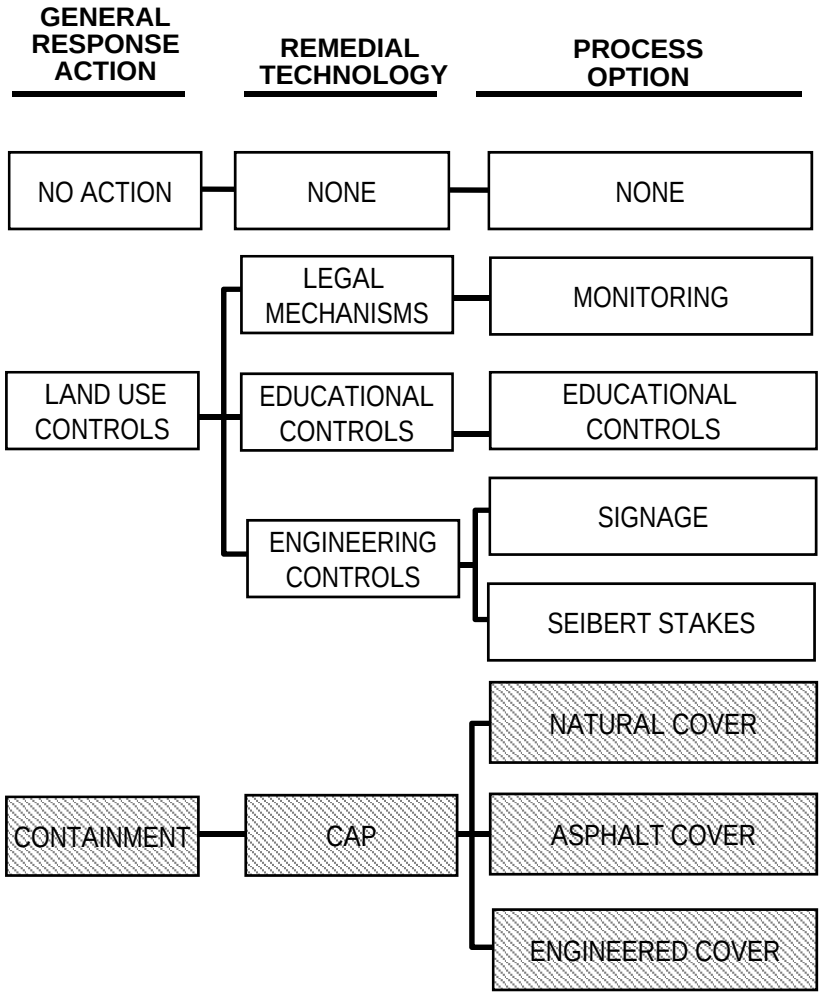
FIGURE 3-2. EVALUATION OF PROCESS OPTIONS
RVAAP-063-R-01 GROUP 8 MRS



EFFECTIVENESS	IMPLEMENTABILITY	COST
Does not mitigate potential explosive hazards.	Not applicable. Retained as a baseline for evaluation of other alternatives.	Capital: None O&M: None
Effective at evaluating current conditions at the MRS but does not reduce contamination.	Exposure hours monitoring is not administratively feasible for receptors accessing the MRS; however, monitoring is administratively feasible for any LUCs implemented for the MRS.	Capital: Med O&M: Low
Effective in training authorized personnel entering an MRS to recognize and avoid MC contamination. This measure is only effective for authorized personnel.	Readily implemented but requires experienced personnel to provide training. This is administratively feasible as OHARNG already conducts training as an interim control.	Capital: Low O&M: Low
Effective at notifying human receptors of potential risks at the MRS.	Readily implemented and administratively feasible as OHARNG has already posted signage as an interim control.	Capital: Low O&M: Low
Effective at defining the boundaries in which potential hazards remain.	Readily implemented and administratively feasible as OHARNG has placed Seibert stakes around the MRS as an interim control.	Capital: Low O&M: Low
Effective at preventing direct exposure to MC, but does not remove the MC.	Readily implemented but not administratively feasible, as it requires routine inspections. Not acceptable for the commercial industrial land use at the MRS.	Capital: Low O&M: High
Effective at preventing direct exposure to MC, but does not remove the MC.	Readily implemented but not administratively feasible, as it requires routine inspections. Not acceptable for the commercial industrial land use at the MRS.	Capital: Med O&M: Med
Effective at preventing direct exposure to MC, but does not remove the MC.	Readily implemented but not administratively feasible , as it requires routine inspections. Not acceptable for the commercial industrial land use at the MRS.	Capital: High O&M: High

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FIGURE 3-2. EVALUATION OF PROCESS OPTIONS
RVAAP-063-R-01 GROUP 8 MRS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
SOIL TREATMENT	EX-SITU PHYSICAL/ CHEMICAL SOIL TREATMENT	CHEMICAL EXTRACTION	Effective at treating MC in soils prior to disposal potentially allowing for non-hazardous waste disposal.	Readily implementable, but quantities of expected soils volumes are too low to make the technology cost-effective compared to other technologies.	Capital: High O&M: None
		ACID EXTRACTION	Effective at treating MC in soils prior to disposal potentially allowing for non-hazardous waste disposal.	Readily implemented but not administratively feasible. Large staging area required to accommodate treatment. Size of MRS and proximity to buildings considered unacceptable.	Capital: High O&M: None
		SOLVENT EXTRACTION	Effective at treating MC in soils prior to disposal potentially allowing for non-hazardous waste disposal.	Readily implemented but not administratively feasible. Large staging area required to accommodate treatment. Size of MRS and proximity to buildings considered unacceptable.	Capital: High O&M: None
		DEHALOGENATION	Effective at treating MC in soils prior to disposal potentially allowing for non-hazardous waste disposal.	Readily implemented but not administratively feasible. Large staging area required to accommodate treatment. Size of MRS and proximity to buildings considered unacceptable.	Capital: High O&M: None
		SOIL WASHING	Effective at treating MC in soils prior to disposal potentially allowing for non-hazardous waste disposal.	Readily implementable, but quantities of expected soils volumes are too low to make the technology cost-effective compared to other technologies.	Capital: High O&M: None
		STABILIZATION/ SOLIDIFICATION	Effective at treating MC in soils prior to disposal potentially allowing for non-hazardous waste disposal.	Readily implemented but not administratively feasible. Large staging area required to accommodate treatment. Size of MRS and proximity to buildings considered unacceptable.	Capital: High O&M: None
		STABILIZATION/ SOLIDIFICATION BY VITRIFICATION	Effective at treating MC in soils prior to disposal potentially allowing for non-hazardous waste disposal.	Readily implemented but not administratively feasible. Large staging area required to accommodate treatment. Size of MRS and proximity to buildings considered unacceptable.	Capital: High O&M: None
MC SOIL REMOVAL	EXCAVATION	HEAVY EQUIPMENT	Effective at removing contaminated soils from the MRS.	Readily implemented and is administratively feasible. OHARNG has conducted soil removal by these methods at Camp Ravenna in the past.	Capital: Med O&M: None
WASTE DISPOSAL	OFF-SITE DISPOSAL	OFF-SITE DISPOSAL FACILITY	Effective at eliminating MC risk from the MRS.	Readily implemented and is administratively feasible. OHARNG has utilized licensed off-site disposal facilities in the past.	Capital: Med O&M: None

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The development and screening of LUCs for this MRS is presented in the IA (Appendix A). This section presents LUC remedial technologies and process options that were retained during the screening process and are retained from the IA.

Monitoring

Monitoring at the MRS is a legal mechanism process option that would include visual and physical inspections of the conditions at the MRS to determine the need for repairs and/or replacement of any engineering controls. These activities ensure early identification and response for any changes in site conditions that may affect risk posed by MC. The process option meets the RAOs since it would be effective at reducing the unacceptable potential hazard of MC at the MRS and would be protective of human health by ensuring that effectiveness of the selected remedial alternative is maintained. This process option is technically feasible to implement since materials and services to conduct monitoring are easily obtainable, but it requires regular visits to the MRS for inspections. It is not administratively feasible to the facility to conduct exposure monitoring for occupational hazards to trainees accessing the MRS; however, periodic monitoring of any engineering controls or other LUCs implemented would be conducted. The appropriate frequency for monitoring would be established to ensure the effectiveness of the remedial alternative and would result in O&M costs until UU/UE (i.e. negligible MC exposure) is achieved.

Educational Controls

Based on information received from CJAG as established in the IA (Appendix A) at this MRS, the educational controls would include programs that notify visitors, CJAG personnel, contractors, and utility workers of existing conditions, existing engineering controls, and potential hazards. Training (e.g., LUC awareness, affected media, and risk mitigation procedures) informs property users of the presence of MC contaminated soils, stressing the importance of personal protective equipment and decontamination. Educational controls can be implemented to provide informational materials on potential MC hazards and steps that can be taken to mitigate exposure risks.

Awareness training is the installation-specific training provided to authorized individuals accessing the MRS. The training is described in the Property Management Plan (USACE, 2012) or the most current version. Awareness training provides an overview of the requirements of the Property Management Plan, the procedures for preventing and reporting LUC violations, and Area of Concern (AOC)/MRS-specific restrictions. The "Land Use and Engineering Controls for each AOC/MRS" section of Appendix A of the Property Management Plan (USACE, 2012) would be updated to include a summary of LUCs developed specifically for this MRS.

The use of educational controls (annual training for facility employees, National Guard trainee in-briefs received upon arrival at CJAG, and contractor/site worker training received prior to entry on the MRS) is already being implemented by CJAG. Educational controls can be implemented easily and at a relatively low cost. Educational controls are retained for further consideration.

Engineering Controls

As described in the IA, engineering controls are physical structures that warn of hazards or prevent access to an MRS. As summarized in the IA, fencing is not applicable for the MRS and is not administratively feasible to OHARNG. The most probable structures for implementation at the former RVAAP MRSs are described below and covered in more detail in the IA.

Signage

Warning signs can be used to notify and inform the public of a potential hazard on a MRS. Signage is currently in place at the Group 8 MRS and is easily implementable for low cost. The use of signage is retained for further consideration.

Seibert Stakes

Seibert stakes are currently in place at the Group 8 MRS. Seibert stakes use red and yellow reflector markings to indicate the boundary of the MRS, as described in the IA (Appendix A). The Seibert stakes are easily implementable for a low cost. The use of Seibert stakes is retained for further consideration.

Summary of Land-Use Controls Process Options

The educational control and engineering control LUCs, as summarized, are retained for this MRS because these LUCs were determined to be effective, and implementable, and relatively low in cost. Therefore, educational controls are carried forward as representative process options for LUCs. It is not administratively feasible to the facility to conduct exposure monitoring for occupational hazards to trainees accessing the MRS; however, periodic monitoring that evaluates the conditions at the MRS and ensures that the LUCs are protective of potential human receptors is implementable and is carried forward as a representative process option for LUCs. In general, LUCs may be evaluated as a sole remedy but may also be integrated to supplement implementation of an engineering remedy. The use of engineering controls such as the interim controls currently in place (signage and Siebert stakes) are retained for consideration as effective, implementable, and cost effective. The use of engineering controls may also be integrated to supplement implementation of a LUCs remedy.

3.2.3 MC Containment

Containment includes technologies that reduce the mobility or accessibility of MC contaminants in the underlying soil. These technologies can effectively reduce contaminant mobility and the potential for receptor exposure. Containment technologies may also mitigate the migration of MC from the by reducing or eliminating water infiltration. Containment may involve placing a physical barrier (horizontal or vertical barriers) between the MC and potential receptors. These types of technologies do not address the hazardous nature or volume of MC, but instead reduce accessibility to contaminants in the underlying soil, as well as limiting their mobility.

Natural Cover

A natural cover includes a simple physical barrier of natural material such as clay, soil or stone placed over the MRS. This process option would be effective at limiting or preventing the direct contact of receptors with MC in soils, but may not reduce the mobility of MC in soil since water infiltration would still occur. There is the potential for erosion of soil cover over time. Established vegetation on a soil cover and engineering controls can help prevent erosion and scouring from occurring. Natural covers are very easy to implement. Standard earthmoving equipment can move local soil or stone over the areas with MC contamination. Maintenance would be required to limit large vegetative growth that could disrupt the cover. Frequent maintenance (mowing) would be required. Natural covers are technically feasible to implement and would be administratively acceptable. The materials and services associated with natural covers are readily available and the associated capital cost is low in comparison to the other containment processes. The O&M costs are

considered high in comparison to the other containment processes since frequent maintenance and inspections would be required to ensure the effectiveness of the cover.

Asphalt Cover

An asphalt cover controls direct exposure of receptors to MC and the potential for migration and mobility of MC through the installation of impermeable asphalt. Asphalt can quickly develop cracks and holes that need to be filled, and maintenance would be needed to repair them as they occur. Asphalt covers are most effective if the area needs to be asphalted for another use that will promote its long-term maintenance, which is not the case of the MRS. Asphalt covers are easy to install and would require minimal clearing of vegetation due to current conditions on the MRS. As with other covers to control infiltration, asphalt covers need to be sloped to encourage runoff during rain events. Frequent maintenance is less necessary than with the other containment process options, as the asphalt covers do not require mowing. However, the asphalt cracks easily and must be controlled to maintain effectiveness. The asphalt cover is technically feasible to implement, but is not consistent with the future land uses at the MRS. The capital cost associated with materials and services of an asphalt cover is moderate in comparison to the other containment processes. The O&M costs are considered moderate, since there is less frequent maintenance and inspections that would be required to ensure the effectiveness of the cover in comparison to the other containment processes.

Engineered Cover

An engineered cover consists of various layers of soil, clay, membranes, and other materials. Engineered covers are applicable for the controlled direct exposure of receptors to MC in soils, and the potential for the migration and mobility of MC at the MRS through the installation of impermeable layer materials. Long-term maintenance would be required to ensure cracks and holes in the cover do not develop. Maintenance would be needed to repair the cracks and holes as they occur. An engineered cover is more difficult to install compared to the natural or asphalt cover options due to the design requirements. As with other covers to control infiltration, engineered covers need to be sloped to encourage runoff during rain events. More maintenance is necessary with engineered covers than the asphalt cover because frequent mowing is required. The engineered cover must be maintained to maintain effectiveness. The OHARNG would not be amenable to the inspection, monitoring, and maintenance required; therefore, this process option would not be administratively acceptable. The materials and services associated with engineered covers are specialized and are not readily available; therefore, capital cost is high in comparison to the other containment processes. The O&M costs are considered high in comparison to the other containment processes, since frequent maintenance and inspections would be required to ensure the effectiveness of the cover.

Summary of Containment Process Options

The natural cover process option provides the least expensive option that meets the needs of a containment option; however, the cover option alone does not remove the MC at the MRS and this process option is more susceptible to erosion and infiltration than the other containment alternatives. There are higher costs associated with the implementation of an engineered cover compared to asphalt cover and both options require long-term O&M. Both asphalt and engineered cover are technically feasible and effective; however, neither are considered administratively feasible and are not acceptable for the commercial industrial land use at the MRS. None of the MC containment options were retained for further consideration.

3.2.4 Soil Treatment

The treatment options evaluated for impacted soils at the MRS 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. Biological and thermal treatment options were eliminated due to the limited effectiveness with the MRS-specific COCs and potential safety concerns, respectively. Additionally, in-situ process options were not retained for further evaluation since they do not physically remove MC contamination, but instead reduce the mobility of the MC that would remain in place. The RI Report concluded and further evaluation in the FS concurred that the MC at the MRS is relatively immobile rendering stabilization of MC unnecessary. Process options evaluated for soil treatment include various ex-situ physical and chemical options.

Ex-Situ Physical/Chemical Soil Treatment

Ex-situ treatment is generally a more effective stabilization technology compared to in-situ treatment because it is easier to thoroughly mix the amendment with excavated soil. The treated soil can be placed back at the site, but more commonly, the technology is used in conjunction with off-site disposal. Ex-situ soil stabilization can be conducted on or off the site. Although on-site treatment is easily implementable and more cost effective it is not administratively feasible. On-site treatment is considered unacceptable due to the size of the MRS, proximity to buildings, and the large staging area required to safely accommodate heavy equipment, soil stockpiles, and project materials. This technology is not retained for further consideration. Off-site treatment at a Treatment, Storage, and Disposal Facility (TSDF) is not retained for further consideration due to higher relative off-site treatment costs. Additionally, off-site treatment is not as cost effective as on-site treatment.

Ex situ physical/chemical treatment can be used on excavated contaminated soils. Chemical extraction and soil washing are similar technologies that use a solvent to extract contaminants from soil. Both technologies were initially screened to be applicable to the MRS COCs, however, the quantities of expected soil volumes are generally too low (between 1,068 and 2,140 CYs) to make these technologies cost-effective relative to other available technologies.

<u>Stabilization/Solidification</u>

Ex situ Stabilization/Solidification (S/S) consists of chemical fixation or vitrification and is used to reduce the mobility of metal and organic-contaminants in waste. These processes are highly effective for immobilizing inorganic contaminants, preventing exposures or migrations to exposure points. Contaminated soils and dry sediment would require excavation and transport to a central staging area for on-site treatment, which would be outside the boundaries of this MRS. The treated waste would require manifesting (if analytical data confirms that off-site disposal is required) and off-site disposal by a licensed transporter for disposal. Qualified vendors and equipment are readily available to perform this treatment operation.

Although technically implementable, this technology generally is limited for soils requiring treatment for SVOCs contamination. This technology is not administratively feasible for OHARNG, as it would have a large footprint, possibly outside the MRS where existing buildings are located. Additionally, following implementation, MC contamination would remain (other than SVOCs) in the soils. The capital cost associated

with this technology is moderate due to disposal costs related to waste volumes requiring off-site disposal. This technology requires long-term management and monitoring due to the potential for remaining contaminants, so the O&M costs are considered higher relative to other technologies.

Summary of Soil Treatment Process Options

In general, the ex-situ physical/chemical soil treatment process option evaluated for the MC present at the Group 8 MRS are not considered technically implementable because they would not treat all MC present and would require a large staging area. Additionally, their application would require significant disturbance to the soils potentially impacting existing structures near the MRS. Other treatment options are not feasible due to the MPPEH co-located with the MC contamination and/or they focus on reducing mobility of MC and the COCs at the MRS are relatively immobile. The ex-situ process options considered are not cost effective to implement due to the low soil volume anticipated (533 CYs). Based on the evaluation of technologies and process options summarized in Figure 3-2, Soil Treatment Process Options are not retained for consideration.

3.2.5 Soil Removal

Excavation and removal of contaminated soil would be conducted in conjunction with disposal of MC contaminated soil. Removing contaminated soil involves bulk excavation with conventional excavation equipment. The selected technique is dependent upon the location to be excavated. Mechanical excavators would be used for easily accessible areas. Smaller mechanical devices or hand tools may be required for less accessible areas. Excavation requires the use of dust and erosion controls. Excavated soils can be transported and disposed of at an on-site or off-site disposal facility. Soil removal is applicable for all COCs at the MRS.

Excavation

Excavation of contaminated soil using heavy equipment can be performed for soil removal. OHARNG has performed soil removal by these methods in the past. This is a standard technology that is effective and implementable, and has been retained for further consideration.

Soil removal is effective in protecting human health and the environment and reducing future MC 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 process option.

Summary of Soil Removal Process Options

Soil excavation is easily implemented using readily available resources and conventional earth-moving equipment. Some ancillary construction activities may be necessary such as a staging area for loading and unloading, soil erosion control, excavation dewatering, water treatment, dust control, and arrangement of staging areas to avoid disruption of the activities currently conducted on the MRS (access to nearby buildings). Administrative coordination between remediation activities and OHARNG operations would be planned to minimize impacts. The capital cost associated with this technology is moderate. There are no O&M costs associated with the removal of contaminated media. Soil removal is applicable for all COCs at the MRS and this process option is retained for further consideration.

3.2.6 Waste Disposal

On-site (on the MRS) and off-site (off the MRS) disposal technologies were considered for the disposal of contaminated soils. The on-site disposal technology is not applicable due to the relatively low volume of contaminated soil and the high cost of constructing a disposal facility on the MRS. Off-site (off the MRS and outside the facility) disposal technology was retained and is discussed further below.

Off-site Landfill Disposal

Soils could be disposed of off-site in a permitted or licensed facility such as a regulated landfill. Transportation could be accomplished using a variety of modes. Handling options for off-site disposal technologies include truck or railcar to transport MC contaminated soil, with truck transport of soils being retained for consideration. Truck transportation could be used to move soils offsite. This process option is technically implementable based on previous disposal activities conducted at RVAAP. Disposal facilities are readily available within a reasonable distance for disposal of potential waste streams. Additionally, licensed transporters are readily available to haul properly documented waste. Offsite disposal options would be effective in separating MC impacted soils from potential receptors. The capital cost associated with this technology is moderate. There would be no O&M costs since soil MC contaminated soils would be removed from the MRS.

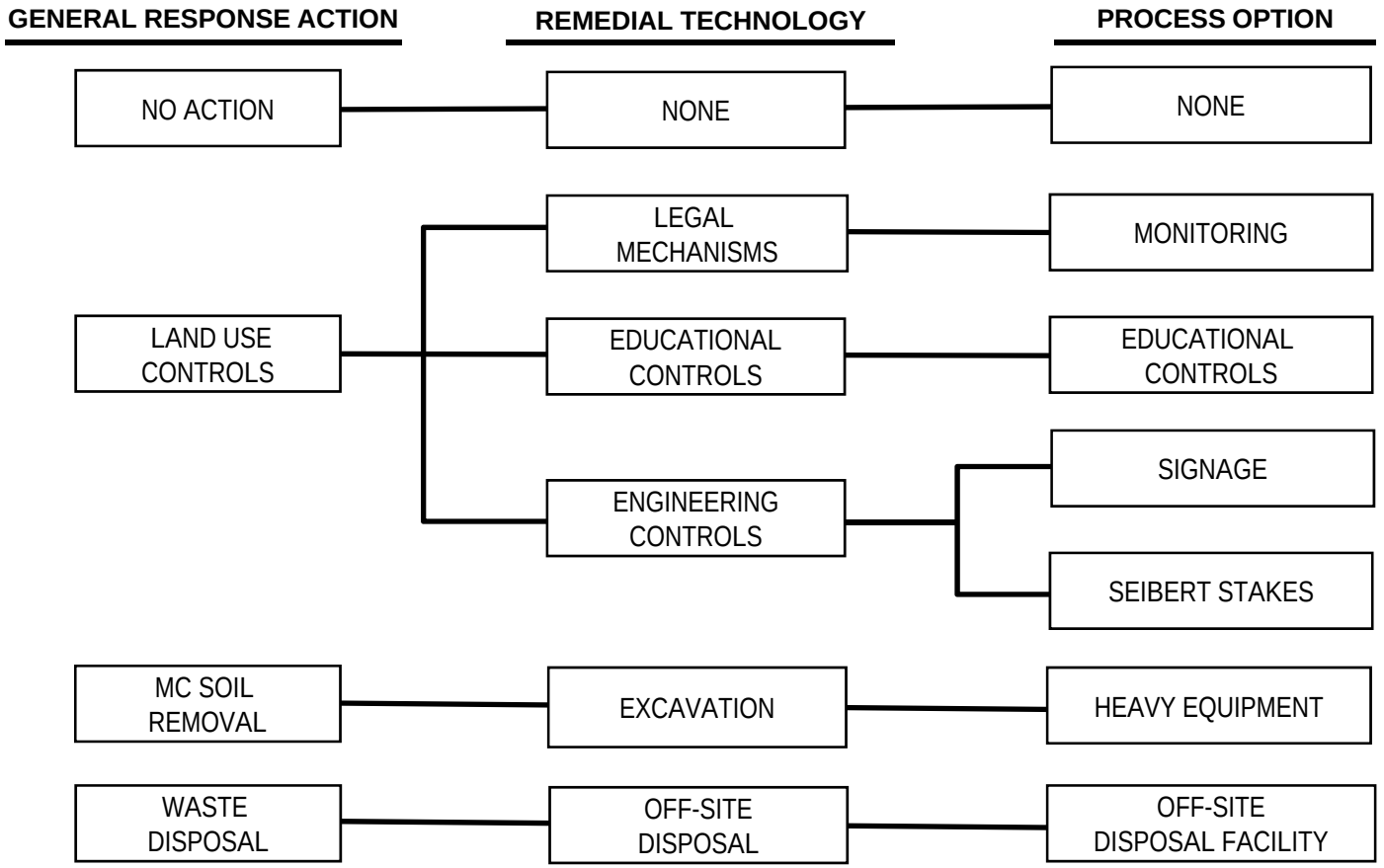
Summary Waste Disposal Process Options

Waste disposal at an offsite disposal facility (landfill) was retained following evaluation. By removing the contaminated soil from the MRS and placing it in a disposal facility, this technology is effective in removing MC risk. The excavated soil will require characterization to determine whether it is nonhazardous or hazardous waste. Nonhazardous waste can be transported to and disposed of at a properly licensed nonhazardous landfill. Characterized hazardous material can either be treated on site and rendered nonhazardous or can be transported to the appropriately licensed hazardous waste landfill for treatment before disposal to ensure compliance with land disposal regulations. This technology is administratively feasible for OHARNG, as it has been used in the past at other locations. Offsite disposal is retained as an effective process option, with moderate cost.

3.3 Process Options Retained for the Evaluation of Remedial Alternatives

The process options that were retained from the representative GRAs for the development of remedial alternatives are presented on Figure 3-3. The development of the screening alternatives are presented and evaluated in Section 4.0.

FIGURE 3-3. RETAINED PROCESS OPTIONS
RVAAP-063-R-01 GROUP 8 MRS



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4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, remedial alternatives are developed by combining the remedial technologies that remain after the screening process completed in Section 3.0. Remedial alternatives are developed with the overall goal of protecting human health and the environment, and of achieving RAOs in a cost-effective manner. Development of remedial alternatives is conducted with consideration of CERCLA Section 121(b), which shows a clear preference for remedies that are permanent, cost-effective, and employ treatment as a principle element to reduce volume, toxicity, or mobility. CERCLA Section 121(b) also states a preference against transport off of the facility (CJAG) and disposal of hazardous substances without such treatment. When hazardous substances are left on site at levels that will not attain UU/UE, CERCLA Section 121(c) requires a review of the protectiveness of the remedy no less than every 5 years (i.e., a Five-Year Review).

Remedial alternatives are assembled, described, and preliminarily screened in this section. Those alternatives that meet the following three criteria are retained for more thorough and extensive analysis in Section 5.0:

- Effectiveness is the ability of a remedial alternative to protect human health and the environment in the short-term (during remedial action) and long-term (post-remedial action). Measures of effectiveness include (1) the degree to which toxicity, mobility, or volume are reduced through treatment; (2) the degree to which adverse effects on human health and the environment are controlled; (3) timeliness; and (4) compliance with ARARs. Remedial alternatives that do not provide adequate protection of human health and the environment are eliminated from further consideration (40 CFR 400.430(e)(7)(i); EPA, 1988).
- Implementability is the ability to implement a remedial alternative at an MRS and is composed of technical and administrative feasibility. The technical feasibility of an alternative refers to the level of effort required to construct, operate, and meet technology-specific regulations for process options until the remedial action is complete. Administrative feasibility addresses the acceptability of an alternative by regulatory agencies/stakeholders and the activities needed to coordinate with other offices and agencies, such as obtaining approvals from stakeholders and establishing easements, etc. Implementability also considers the availability of resources required to implement specific components of an alternative and the ability to obtain them.
- Costs are composed of capital costs associated with upfront implementation and long-term O&M costs associated with ongoing implementation and/or monitoring costs. Ranges or approximations of relative capital and O&M costs are used rather than detailed estimates. Present worth analyses are used to evaluate those expenditures that occur over different time periods. All costs are discounted to a common base year. Alternatives can be eliminated when their costs are deemed excessive relative to their overall effectiveness. Alternatives that provide effectiveness and implementability like those of other alternatives, but at a greater cost, can be eliminated (40 CFR 400.430(e)(7)(iii); EPA, 1988).

4.1 Development and Screening of Alternatives

This section identifies potential remedial alternatives to be screened for the Group 8 MRS. Several alternatives were developed and preliminarily considered to address RAOs in the MRS. The alternatives are as follows:

- Alternative 1 - No Action;
- Alternative 2 - LUCs; and
- Alternative 3 - MC Contaminated Soil Removal.

4.2 Screening of Individual Alternatives

This section presents the preliminary screening of the alternatives identified in Section 4.1.

4.2.1 Alternative 1 - No Action

The NCP requires that the No Action alternative be evaluated to provide a baseline for comparison to other alternatives. This alternative provides no actions to protect human health or the environment at the MRS. As this is required per the NCP, no preliminary screening is necessary, and this alternative is retained for the detailed analysis of alternatives in Section 5.0.

4.2.2 Alternative 2 - Land Use Controls

The LUCs alternative would not include any active removal at the MRS. Rather, it would focus on reducing human exposure (for those receptors with current or future risk: Industrial Receptor, National Guard Trainee and Residential Receptor) to MC hazards by managing the activities occurring at the MRS and performing periodic monitoring to evaluate the conditions of the MRS. The LUCs under Alternative 2 would include educational controls and monitoring that were developed through the IA (Appendix A) and described below.

The educational controls would consist of an annual awareness training program to notify authorized personnel of existing conditions, existing engineering controls (Siebert stakes and signage), and MC risk mitigation procedures (i.e., PPE, decontamination, etc.) at the MRS. Annual inspections and completion of the Property Management Plan Inspection Form would be conducted to monitor the LUCs. Five-Year Reviews would be required to ensure the effectiveness of this alternative because it does not achieve UU/UE at the MRS.

Effectiveness: Alternative 2 would not reduce mobility or volume of MC through treatment and the toxicity concerns associated with MC would not be reduced. Once implemented, educational controls consisting of annual training would be effective at mitigating the short-term hazards at the MRS by educating the Industrial Receptor who may have access to the MRS about potential hazards; however, they are not effective for unauthorized personnel or trespassers who are unaware of the hazards at the MRS. This alternative would be effective at protecting human health in the short-term because no active work would be performed at the MRS. This alternative does not remove hazards; rather it relies on LUCs, which require continual implementation, and the long- term effectiveness of this alternative will be met. The overall and long-term effectiveness of the LUCs depends on the support, involvement, and willingness of the OHARNG to enforce and maintain the educational controls emplaced to modify behavior. The ARNG has authority to effectively maintain and enforce LUCs at CJAG; however, ARNG, as a national institution, has delegated that authority to the OHARNG at CJAG. LUC awareness training is already in place as an interim control for the MRS, and

the OHARNG/CJAG is willing to maintain educational controls and conduct periodic monitoring in support of the CERCLA Five-Year Reviews over the long term. Because the MRS will remain under OHARNG/CJAG control, Alternative 2 is effective in the long term. There are no location-, or action-specific ARARs identified for this alternative. The only chemical specific ARAR is the TSCA as it is relevant and appropriate for PCBs. The site concentrations for PCBs measured during the RI are below TSCA required levels; therefore, compliance with ARARs will be accomplished for human receptors by this alternative by modifying human receptor behavior to avoid exposure to MC contaminated soil.

Implementability: LUCs are considered technically and administratively feasible for the MRS. The use of educational controls (annual training for OHARNG/CJAG employees, National Guard trainee in-briefs, and contractor/site workers training prior to MRS access) is being implemented by CJAG as a required procedure. The materials and services that will be required to implement the LUCs are readily available.

Cost: The capital costs for Alternative 2 include preparation of the LUCs Implementation Plan ($9,758) and initiation of the training activities for the MRS ($5,057). Incorporating the LUCs into the Property Management Plan is already funded and will be completed under an existing contract. The total capital costs for this alternative are $20,445 and include administrative and contingency costs. The timeliness of this alternative includes a duration of initial preparation through final approval of the LUCs Implementation Plan of six months. The training includes different levels of awareness training dependent on the personnel and activities to be conducted and would occur on an annual basis over a 30-year performance period ($2,796 annually). The discounted O&M costs over the 30-year duration, including administration and contingency costs are $77,608. Periodic costs include monitoring in support of the CERCLA Five-Year Reviews ($5,305) The monitoring would occur at the same time as the Five-Year Reviews in Years 5, 10, 15, 20, 25, and 30. The total periodic costs over the 30-year performance period, including administration and contingency costs, are $43,926. The total discounted cost estimate for Alternative 2 that includes the combined capital, O&M, and periodic costs is $125,904.

The costs associated with the Five-Year Reviews are not included in the total cost for Alternative 2 since they are a CERCLA requirement and are not a component of the proposed remedy. The duration of each Five-Year Review would take approximately six months to complete between the initial preparations through final approval of each report. The total discounted costs of the CERCLA Five-Year Reviews, including administration and contingency costs, that are estimated over the 30- year performance period is $94,175.

Overall Evaluation: Alternative 2 is implementable, as educational controls are already being implemented by the facility. Additionally, Alternative 2 is effective because the MRS will remain under OHARNG/CJAG control, and the OHARNG/CJAG is willing to maintain educational controls and conduct periodic monitoring to evaluate the conditions at the MRS and ensure that the LUCs are protective of potential human receptors over the long term. Costs associated with Alternative 2 are considered reasonable relative to the overall effectiveness of Alternative 2. This alternative is retained for further evaluation in Section 5.0.

4.2.3 Alternative 3 - MC Contaminated Soil Removal (UU/UE)

Alternative 3 would use a combination of mechanical and manual excavation techniques to remove the MC-contaminated soil to a depth of 0.5 ft bgs in the area of GR8SS-004M that exceeds the PRGs for cadmium. This would remove the risk to the potential future Resident Receptor (Adult and Child) and also be protective for the National Guard Trainee and Industrial Receptor. Alternative 3 would result in conditions allowing for UU/UE for Unrestricted (Residential) Land Use at the MRS. Implementation of Alternative 3 and removal of

MC-contaminated soil throughout the MRS would achieve the RAO designed to protect the potential future Resident Receptor from potential exposure to cadmium in soil. Incidental to the surface soil removal, should any munitions debris be encountered, it will be segregated, inspected, and certified as MDAS prior to disposal.

Confirmation Soil Samples will be collected to confirm the extent of MC- contaminated soil is removed that exceeds the remediation goals for cadmium. The confirmation soil samples for laboratory analysis will be collected immediately below the 0.5 feet to confirm all MC contamination has been removed. Samples of stockpiled, excavated soils will be collected and analyzed to determine if the soil meets the definition of characteristic hazardous waste pursuant to 40 CFR Part 261 using the Toxicity Characteristic Leaching Procedure (TCLP). The excavation locations within the MRS will be planned so that areas where there are potentially hazardous contaminant levels are managed separately. If characterization results indicate that excavated material is hazardous, it will be segregated from non-hazardous soils for proper offsite disposal. All MC-contaminated soil within the first 0.5 ft bgs will be excavated, sampled, and characterized for disposal. For MC contaminated soil shown to be meet non-hazardous disposal criteria, the soil will be transported to a non-hazardous landfill for proper disposal. After the initial removals have been conducted, confirmation samples (from 6-inches to 1-foot) will be collected from each excavation to confirm that MC contaminated soil to a depth of 6 inches has been excavated and removed. If indicated, localized areas may require further limited excavation following the confirmation sampling to deeper than 6-inches, and this additional excavation will be accomplished and additional confirmation samples collected to confirm the extent has been removed.

MC Contaminated Soil Removal would be accomplished following additional sampling activities and laboratory analysis. Based on the RI recommendations, the estimated maximum contaminated soil volume is 533 CYs. MC risks will be addressed through removal of confirmed MC-contaminated soil to the below listed standards (there is no risk to the current land use applicable Industrial Receptor). MC contaminated soil at the MRS consists of:

- Surface soils (0 to 0.5 feet bgs) which exceed the PRG (HHRA risk-based remediation goals) for hazards to the Resident Receptor (Adult and Child) for cadmium. Removal of these soils will be protective of the National Guard Trainee (a potential future receptor) and the Industrial Receptor (the current receptor). The EPA residential soil RSL of 71 mg/kg is identified as the PRG for cadmium in surface soil. (see Section 2.4.1).

Additional site restoration activities will be conducted, including grading the site and installation of confirmed clean soil to backfill and level all excavated areas. The excavated areas will be reseeded with native vegetation or gravel replaced to restore the existing roadways within the MRS.

Effectiveness: Alternative 3 would be effective at reducing the volume of MC contaminated soils through treatment to a negligible probability of exposure (i.e., UU/UE) and would be protective of human health and the environment, which is a CERCLA preference. There are no chemical-specific ARARs identified for this MRS; however, the TBC requirements would be met by the removal of MC contaminated soil to the PRGs. There are no location-specific ARARs for this Alternative 3. A potential for surface soil disturbance exists from Alternative 3 that may contribute to erosion and sedimentation; therefore, erosion and sediment control in accordance with OAC 1501:15-1-04 is identified as an action-specific ARAR for the MRS. Because the MRS will remain under OHARNG/CJAG control, Alternative 3 is effective in the long term.

Implementability: This type of removal action under Alternative 3 is technically and administratively feasible to implement, with an estimated time of approximately 1 year for planning and implementation. Minimal vegetation removal would be necessary, as the MRS is either grass or gravel covered. Rapid regrowth of the vegetation is expected. This alternative would require approvals from the OHARNG for conducting anticipated activities.

Cost: The capital costs for Alternative 3 include the development of the planning documents and engineering support ($57,199), field work for the MC soil removal ($328,072), and follow on final reports ($40,592). The total capital costs for this alternative are $587,690, including administration and contingency costs. The duration for initial preparation through final approval of the work plan would be nine months. The timeliness for completion of this alternative includes duration of field activities of approximately 4 weeks for mobilization/demobilization, sampling, MC contaminated soil excavation, and site restoration. The duration of the initial preparation through final approval of the remedial action completion report would be six months. LUCs and Five-Year Reviews would not be required for Alternative 3. The total discounted cost estimate for Alternative 3 that includes the capital costs is $587,690. Since this alternative achieves a negligible probability of exposure (i.e., UU/UE) for the future Resident Receptor (Adult and Child), there would be no need to implement LUCs. As a result, there are no O&M, periodic, or Five-Year Review costs associated with Alternative 3.

Overall Evaluation: Alternative 3 includes initial surface soil sampling, removal, and proper disposal of the MC-contaminated soils to 0.5 feet bgs. This response action would achieve negligible probability of exposure to a chemical hazard at the MRS (i.e., UU/UE) for the Residential Receptor, which is a CERCLA preference. Following implementation of the remedy, there will be no risks to human health or the environment. No LUCs or O&M activities would be required following the completion of Alternative 3. Alternative 3 meets the criteria for effectiveness, implementability, and costs and is retained for further evaluation in Section 5.0.

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5.0 DETAILED ANALYSIS OF ALTERNATIVES

In this section, the remedial alternatives developed in Section 4.0 and retained for further evaluation are analyzed in detail. All three alternatives were retained for detailed analysis. The detailed analysis consists of evaluating each alternative using the nine CERCLA criteria listed in the NCP. The purpose of this detailed analysis of alternatives is to provide performance and cost data that can be utilized to provide a basis for optimal remedy selection.

5.1 Overview of Evaluation Criteria

Section 300.430(e) of the NCP lists nine CERCLA criteria against which each remedial alternative must be assessed. The acceptability or performance of each alternative against the criteria is first evaluated individually so that relative strengths and weaknesses may be identified.

The NCP [Section 300.430(f)] states that the first two criteria, protection of human health and the environment and compliance with ARARs, are "threshold criteria" that must be met by the selected remedial action unless a waiver is granted under Section 121(d)(4) of CERCLA. The next five criteria are "primary balancing criteria," and the trade-offs within this group must be balanced. The preferred alternative will be the alternative that is protective of human health and the environment, is ARAR-compliant, and provides the best combination of primary balancing attributes. The final two criteria, state and community acceptance, are "modifying criteria" which are evaluated following the comment period on the FS and the proposed remedial plan. The detailed criteria are as follows:

Threshold Criteria:

Overall Protection of Human Health and the Environment – A determination and declaration that this criterion will be met by the proposed remedial action must be made in the Record of Decision (ROD); therefore, the selected remedy must meet this threshold criterion. The threshold criterion will be met if the risks associated with human exposures are eliminated, reduced, or controlled through treatment, engineering, or LUCs, and if the remedial action is protective of the environment.

Compliance with ARARs – Compliance with ARARs is a threshold criterion that must be met by the proposed remedial alternative. The remedial alternative will meet this criterion if all chemical-specific, action-specific, and location-specific ARARs are met by the alternative. For those ARARs that are not met, a determination will be made as to whether a waiver is appropriate. It should be noted that the ARARs presented in this FS are preliminary. Final ARARs and compliance determinations will be made in the ROD.

Balancing Criteria:

Long-Term Effectiveness and Permanence – The level of risk associated with MC contamination and treatment residuals after implementation of the remedial alternative will be evaluated based on the following factors:

- Magnitude of residual hazards remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities

- Adequacy and reliability of controls, such as containment systems and institutional controls, necessary to manage treatment residuals and untreated waste

Reduction of Toxicity, Mobility, or Volume Through Treatment – The statutory preference for remedial technologies that significantly and permanently reduce the toxicity, mobility, or volume of the waste is addressed by this criterion. The following factors will be considered:

- The amount of hazardous materials that will be destroyed or treated;
- The degree of expected reduction in toxicity, mobility, or volume;
- The degree to which the treatment will be irreversible;
- The type and quantity of treatment residuals that will remain following treatment;
- Treatment processes the alternatives employ and the materials they will treat; and
- Degree to which treatment reduces the inherent hazards posed by the principal threats at the MRS

Short-Term Effectiveness – The effects of the remedial alternative from the beginning of construction and implementation to the completion of the remedial alternative are addressed under this criterion. The following factors will be addressed.

- Protection of the community during the remedial action, such as protection from intentional and unintentional detonations, transportation of contaminated materials, and air -quality impacts from disposal or treatment within the MRS;
- Potential impacts on workers during the remedial action and the effectiveness and reliability of any protective measures;
- Environmental impacts of the remedial action and the effectiveness and reliability of mitigating measures; and,
- Time required to achieve remedial response objectives.

Implementability – The technical and administrative feasibility of implementing the remedial alternative will be addressed. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete; it also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, into the future after the remedial action is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services; and the requirements for, and availability of, specific equipment and technical specialists.

Cost – Capital, O&M, and periodic costs are estimated for each remedial alternative based on quotes for labor, materials, and equipment necessary to implement the alternative. For annual O&M costs, the net present value is calculated over the expected period of years it will take to implement the alternative based on real discount rates contained in Office of Management and Budget Circular A-94 (similar to interest rates) that vary according to the period of performance for federal projects. For the purposes of evaluating and comparing alternatives as specified in the RI/FS Guidance (EPA, 1988), a period of 30 years is used for estimating O&M costs. Periodic costs are those costs that occur only once every few years (e.g., Five-Year Reviews, equipment replacement) or occur only once during the entire O&M period or remedial timeframe (site closeout, remedy failure/replacement). These costs may be capital or O&M costs but, because of their periodic nature, it is more practical to consider them separately in the estimating process. EPA provides guidelines for estimating remedial alternative costs in A Guide to Developing and Documenting Cost

Estimates during the Feasibility Study (EPA, 2000). These cost estimates are intended to have an accuracy of +50 percent / -30 percent. Cost estimating assumptions, unit costs, and real discount rates (that vary according to the period of performance) that are associated with implementation of the remedial alternatives are provided in Appendix B.

Modifying Criteria:

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into the FS and during the future submittals of the Proposed Plan and the ROD.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

5.2 Individual Analysis of Alternatives

Three alternatives were developed and carried forward to address MC contamination for the Group 8 MRS. These alternatives are as follows:

- Alternative 1 - No Action;
- Alternative 2 - LUCs; and
- Alternative 3 – Surface MC Contaminated Soil Removal (UU/UE).

The following sections provide a detailed analysis of these alternatives according to the nine NCP criteria.

5.2.1 Alternative 1 - No Action

Description – This alternative assumes no further action would be taken to address RAOs. This alternative is provided as a baseline for comparison to the other remedial alternatives, as required under CERCLA and the NCP.

Overall Protection of Human Health and the Environment – The No Action alternative does not decrease the risk to human receptors due to MC in soil, since no remedial activities would be implemented at the MRS. Potential hazards associated with direct contact through handle/tread underfoot and direct contact through intrusive activities are not addressed. This alternative is not protective of human health and the environment and does not meet this criterion.

Compliance with ARARs – There are no chemical-specific, location-specific, or action-specific ARARs identified for this alternative. Because no actions will be implemented under Alternative 1, no location- or action-specific ARARs are triggered. Therefore, Alternative 1 meets this criterion.

Long-Term Effectiveness and Permanence – In the long term, this alternative would not be effective because no actions would be taken to reduce risk to human receptors due to MC in soil. No actions would be taken to reduce the magnitude of residual risks, and no institutional controls would be used to manage untreated waste.

Reduction of Toxicity, Mobility, or Volume through Treatment – No treatment is employed as part of the No Action alternative. As a result, this alternative would not satisfy the statutory preference for employing

treatment as a principal element. This alternative would not reduce the toxicity, mobility, or volume of MC contaminated soil remaining in the surface.

Short-Term Effectiveness – Because no active remediation activities are conducted, no additional hazards above those associated with the residual MC in soil would be posed to current receptors or the future industrial receptor as a result of implementing this alternative. This alternative would not cause any adverse short-term effects on the environment.

Implementability – The No Action alternative does not involve active remediation; therefore, technical feasibility is not a consideration. This alternative will not interfere with any planned remedial action in the future. This alternative is not expected to receive Ohio EPA concurrence due to no actions being taken to mitigate the risks at the MRS. This alternative is not administratively feasible to OHARNG/CJAG, as no reduction in explosive hazard would occur.

Cost – The No Action alternative does not have any capital or O&M costs associated with it.

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into this FS and during the future submittals of the Proposed Plan and ROD.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

Overall Evaluation – Although No Action is technically implementable and there are no costs, this alternative does not take action to mitigate residual MC risks. As a result, this alternative is not protective of human health and the environment. As a result, Alternative 1 would not meet the RAOs.

5.2.2 Alternative 2 - Land Use Controls

Description – The LUCs alternative includes no removal of MC contaminated soil within the MRS. Rather, it focuses on reducing human exposure to MC in soil by managing the activities occurring at the MRS and performing periodic monitoring to evaluate the conditions of the MRS. Educational controls deployed as part of this alternative consist of annual training for authorized personnel who would be working at or in the vicinity of the MRS. The training would include LUC awareness, existing engineering controls, and MC risk mitigation procedures for MC contaminated surface soil at the MRS. Monitoring would be conducted in support of the CERCLA Five-Year Review and would evaluate the conditions at the MRS and ensure that the LUCs are protective of potential human receptors (for those receptors with current or future risk: National Guard Trainee and Residential Receptor).

Overall Protection of Human Health and the Environment – The LUCs alternative would not actively treat or remove MC at the MRS; however, it would isolate receptors from potential exposure to MC through behavior controls (i.e., LUC awareness, existing engineering controls, and risk mitigation procedures). LUCs are not protective of environmental receptors. Therefore, this alternative does not meet the overall protectiveness criterion for the environment from risks posed by MC contamination.

Compliance with ARARs – There are no location-specific, or action-specific ARARs identified for this alternative. The TSCA is a relevant and appropriate chemical-specific ARAR for PCBs; however, all site concentrations are less than the cleanup standard. Modification of human receptor behavior will prevent

exposure of human receptors to MC contaminated soil. Therefore, Alternative 2 meets this criterion for human receptors.

Long-Term Effectiveness and Permanence – The LUCs alternative does not involve active treatment or removal of MC contamination from the MRS. In the absence of an active remedy or removal process, MC in soil would remain in place at the MRS above levels that allow for UU/UE. The LUCs would reduce the magnitude of residual hazards by mitigating exposure to the MC contamination by providing human receptors with the information necessary to avoid exposure at the MRS. Periodic monitoring in support of the CERCLA Five-Year Reviews would ensure the LUCs maintain their effectiveness and are protective of the Industrial Receptor in the long term. The Five-Year Reviews would be necessary until UU/UE (i.e., negligible probability) is achieved to verify this alternative remains effective. The LUCs would require continual implementation to ensure long-term effectiveness. The ARNG has financial capability, and both the ARNG and OHARNG are willing to implement LUCs. Therefore, the LUCs are adequate and reliable controls in the management of residual hazards associated with the MRS, and long-term effectiveness is ensured.

Reduction of Toxicity, Mobility, or Volume through Treatment – This alternative would not involve active treatment, containment, removal, or disposal of MC contamination in soil at the MRS. Because no treatment would be implemented, there would be no reduction in toxicity, mobility, or volume. This alternative does not satisfy the statutory preference for employing treatment as a principle element.

Short-Term Effectiveness – The short-term hazards posed to the human receptor at the MRS are contact with surface MC contamination in soil. The implementation of the LUCs that include hazard awareness, existing engineering controls, and risk mitigation procedures at the MRS reduces the risk of exposure in the short-term for the Industrial Receptor by providing them with the necessary information to identify and mitigate the potential for direct contact with MC contaminated soils. The implementation of LUCs would not introduce short-term risks to the human receptors and the environment. This alternative's remedial measures would require less than 1 year to complete, but would require long-term O&M in the form of annual implementation of LUCs (30 years assumed for cost estimating purposes).

Implementability – The LUCs alternative does not involve removal of MC contaminated soil. The implementation of LUCs as described is technically implementable. This alternative will not interfere with any planned remedial action at the MRS in the future. Preparing an appendix to the *Camp Ravenna Property Management Plan* and implementing the LUCs (annual educational controls training and periodic monitoring in support of the Five-Year Reviews) is technically implementable and administratively feasible.

Cost – The capital costs associated with implementation for Alternative 2 is $20,445. The capital costs occur in Year 0 and include preparation and implementation of the LUC Implementation Plan and the initial LUCs training event that will then occur on an annual basis. The discounted O&M cost for Alternative 2 is $77,608 and includes the annual LUCs training for the MRS. The O&M costs start in Year 1 and are estimated over a 30-year performance period. Periodic costs are also estimated over a 30-year performance period and include monitoring in support of the CERCLA Five-Year Reviews. The monitoring would occur at the same time as the Five-Year Reviews in Years 5, 10, 15, 20, 25, and 30. The periodic costs for Alternative 2 are $43,926. The total discounted cost estimate for Alternative 2 that includes the capital, O&M, and periodic costs is $125,904. This estimate includes administrative and contingency costs. The costs of the Five-Year Reviews are not included with the total cost of the alternative since it a CERCLA requirement when UU/UE is not achieved and is; therefore, not a component of the proposed remedy. The discounted costs associated

with the Five-Year Reviews over the 30-year performance period are $94,175. The detailed breakdown of the costs for Alternative 2 is provided in Appendix B.

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into this FS and during the future submittals of the Proposed Plan and the ROD.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

Overall Evaluation – Alternative 2 takes action to mitigate MC risks at the MRS through behavior controls to prevent contact of the human receptors with the MC contaminated soils. Monitoring would be conducted in support of the CERCLA Five-Year Reviews and would evaluate the conditions at the MRS and ensure that the LUCs are protective of potential human receptors. This alternative is technically implementable and administratively feasible, is protective of human health, and there are ARAR compliance will be achieved. LUCs would not be protective of environmental receptors. The implementation of LUCs would prevent the Industrial Receptor from direct contact with the MC contaminated soils at the MRS and ensure that the effectiveness of the LUCs is maintained. This would reduce the unacceptable MC risks at the MRS such that the likelihood of the Industrial Receptor encountering MC via direct contact is negligible. As a result, Alternative 2 meets the RAOs for the human receptors.

5.2.3 Alternative 3- MC Contaminated Soil Removal (UU/UE)

Description – Alternative 3 includes complete removal of MC-contaminated soil to 0.5 feet bgs at the location of GR8SS-004M. This would meet the RAO designed to prevent exposure of a future Resident Receptor (Adult and Child) to cadmium. The cadmium is present in surface soils (0 to 0.5 feet bgs) at the location of sample GR8SS-004M at concentrations that exceed PRGs (see Section 2.4.1). Under this alternative, all MC contaminated soil exceeding PRGs would be removed, allowing for UU/UE at the MRS (though there are no current plans to change land use to a Residential land use).

Overall Protection of Human Health and the Environment – Alternative 3 would involve the active removal of MC-contaminated soils to the depth of 0.5 feet bgs. No hazards would remain at the MRS following the completion of this alternative. This alternative is protective of human health and the environment and meets the criterion.

Compliance with ARARs – This alternative could be performed in a manner that complies with all chemical-specific and action-specific ARARs identified in Section 3.2. The soil sampling to be accomplished during the performance of the MC soil removal would verify that soil remaining at the MRS does not exceed the chemical-specific TBCs identified and the chemical-specific ARAR identified (the TSCA for PCBs). No vegetation clearance is anticipated. Excavation of soil may potentially cause on soil erosion; however, the site would be restored with clean backfill materials site vegetation restored once the absence of MC contamination is confirmed. Therefore, adherence to the Ohio General National Pollutant Discharge Elimination System (NPDES) Permit and Erosion and Sediment Control requirements would be required. The future soil removal will not require obtaining a NPDES permit, but the facility will comply with erosion control requirements. Alternative 3 meets this criterion.

Long-Term Effectiveness and Permanence – This alternative involves active removal of MC contaminated soil and allows for UU/UE at the MRS. No potential source for future MC contamination would remain at the

MRS. Alternative 3 would result in the complete removal of MC-contaminated soil to a depth of 0.5 feet bgs; therefore, no residual hazards to a Residential Receptor would remain at the MRS. The magnitude of the hazards would be reduced to none, and no residuals or untreated waste would remain. As a result, Alternative 3 would achieve long-term effectiveness and permanence at the MRS.

Reduction of Toxicity, Mobility, or Volume through Treatment – Alternative 3 would be effective at reducing the mobility and volume of MC in soils through removal to a negligible probability of exposure (i.e., UU/UE) for a Residential Receptor, which is a CERCLA preference. Toxicity associated with MC would be completely removed from the MRS; therefore, the volume would be reduced by removal of MC contaminated soil.

Short-Term Effectiveness – The removal of MC contaminated soils under Alternative 3 would present a chemical hazard to personnel through handling, removal, and restoration activities. Manual excavation presents the greatest short-term risk to personnel conducting the work. These hazards would be mitigated by implementing various personal and procedural levels of protection (i.e., personal protective equipment [PPE], establishing exclusion zone, etc.). The only risk to receptors are present in soils to a depth of 0.5 feet bgs at the location of sample GR8SS-004M. The alternative's remedial measures would require one year to complete with no requirements for O&M.

Implementability – Alternative 3 is technically and administratively feasible to implement. Coordinated planning would be required with the OHARNG/CJAG to minimize disruptions and/or impacts to CJAG operations at surrounding properties during implementation of the remedial action. The services and materials required to implement Alternative 3 are readily available.

Cost – The capital costs associated with up front implementation for Alternative 3, including administrative and contingency costs, are $587,690. The capital costs occur in Year 0 and include MC contaminated soil removal and site restoration. This alternative achieves a negligible probability of exposure (i.e., UU/UE) for the Residential Receptor; therefore, there are no O&M, periodic, or Five-Year Review costs for this alternative. The detailed breakdown of the costs for Alternative 3 is provided in Appendix B.

State Acceptance – This criterion will be evaluated during incorporation of regulatory review comments into this FS and during the future submittals of the Proposed Plan and the ROD.

Community Acceptance – This criterion will be evaluated when the Proposed Plan is presented to the public for review and comment.

Overall Evaluation – Alternative 3 mitigates the risk of potential exposure to MC in soil at the MRS through removal of MC contaminated soil to negligible probability of exposure to identified receptors (i.e., UU/UE for the Residential Receptor for MC), which is a CERCLA preference. This alternative is technically implementable and administratively feasible and is protective of human health. As a result, Alternative 3 meets the RAOs.

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6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The detailed analysis performed in Section 5.0 discussed the degree of compliance to the evaluation criteria for each remedial alternative. To aid in identifying and assessing relative strengths and weaknesses across the remedial alternatives, this section provides a comparative analysis of the alternatives so that the most appropriate remedial alternative can be selected.

6.1 Comparative Analysis by Criteria

Overall Protection of Human Health and the Environment – Alternative 1 takes no action and is therefore not protective of human health and the environment and does not meet this criterion. Alternative 2 is protective through use of LUCs to modify human behavior and limit exposure to MC. Alternative 3 would ensure that MC contaminated soils are removed to a maximum exposure depth of 0.5 feet bgs for protection of all human receptors (allowing for UU/UE).

Compliance with ARARs – There are no location-specific, or action-specific ARARs identified for Alternative 1 and Alternative 2. Under Alternative 3, the vegetation clearing and soil excavation activities have the potential to allow for erosion caused by wind or water erosion of soil and the State of Ohio Soil and Sediment Erosion Control Standards are applicable. Therefore, the potential action-specific ARAR identified for Alternative 3 was the State of Ohio erosion and sediment control regulations. These regulations would be considered relevant and appropriate due to manual and heavy equipment excavation activities that may disturb the land surface enough to contribute to erosion and sedimentation. Also applicable to Alternative 3, there are no chemical-specific ARARs identified for this MRS; however, the applicable TBC requirements would be met by the removal of MC contaminated soil to the PRGs to the depth of 0.5 feet bgs. Alternative 3 meets this criterion. There is one chemical-specific ARAR identified for PBCs in the TSCA (40 CFR 761.61), which is 1 mg/kg for high occupancy areas. Because site concentrations are less than the cleanup standard, the TSCA is relevant and appropriate. Only Alternative 3 is in compliance with the TSCA ARAR.

Long-Term Effectiveness and Permanence – Alternative 1 takes no action and therefore does not provide long-term effectiveness and permanence. There are different degrees of long-term effectiveness and permanence associated with Alternative 2 and Alternative 3. Because Alternative 2 relies on LUCs, its effectiveness and permanence depends on maintaining the educational controls emplaced to modify behavior and conducting periodic monitoring to evaluate the conditions at the MRS and ensure the LUCs are protective of the MC risk to receptors. LUC awareness training is already in place as an interim control for the MRS, and the OHARNG/CJAG is willing to maintain educational controls and conduct periodic monitoring over the long term. Because the MRS will remain under OHARNG/CJAG control, Alternative 2 is effective in the long term and permanent. However, MC contaminated soils constituting a risk to potential future Residential Receptors would not be permanently removed under Alternative 2 in comparison to Alternative 3. In comparison to Alternative 3, Alternative 2 is likely the least effective. Alternative 3 would involve the complete removal of MC contaminated soils to 0.5 feet bgs for MC constituting a risk to Residential Receptors. Confirmation soil samples would verify that all MC contaminated soiled were removed prior to site restoration. The magnitude of the chemical hazards would be eliminated under Alternative 3, and no residuals or untreated waste that would represent the potential for exposure to the Industrial Receptor would remain. As a result, Alternative 3 best achieves long-term effectiveness and permanence at the MRS.

Reduction of Toxicity, Mobility, and Volume through Treatment –Alternative 1 takes no actions and; therefore, does not provide reduction of toxicity, mobility, or volume through treatment of MC at the MRS. Alternative 2 provides no treatment or removal of MC contaminated soils. Therefore, Alternative 2 does not satisfy the statutory preference for employing treatment as a principal element. Alternative 3 includes the removal of MC in soil that would result in a negligible probability of exposure for the Residential Receptor (i.e., UU/UE). Therefore, the reduction of toxicity, mobility, and volume through removal of MC at the MRS under Alternative 3 is greatest. Alternative 3 meets the statutory preference.

Short-Term Effectiveness – Alternative 1 consists of No Action and the risk due to MC is unaltered in the short-term. Alternative 1 does not have any adverse short-term effects. Under Alternative 2, no removal actions will be conducted at the MRS that eliminate any potential for worker exposure or short-term risks to facility employees beyond the baseline conditions. The LUCs to be implemented under Alternative 2 can be quickly established and will further reduce short-term risks by mitigating the potential for exposure to MC at the MRS through behavior controls. Therefore, the short-term effectiveness for Alternative 2 is considered acceptable. The short-term effectiveness of Alternative 3 is affected by the handling, removal, and restoration activities associated with complete excavation of the MRS to a depth of 0.5 ft bgs. Soil disturbance from excavation to 0.5 feet bgs for Alternative 3 is potentially significant and short-term risks would be minimized by adherence to erosion control requirements. The short-term effectiveness of Alternative 3 is considered to be low in comparison to Alternatives 1 and 2, however, the short-term risk is considered acceptable due to the measures that will be taken to mitigate risks associated with exposure to chemical hazards.

Implementability – Although easy to technically implement, Alternative 1 would be the least administratively feasible to implement because the stakeholders are not likely to accept No Action as a remedy. Alternative 2 and Alternative 3 are technically and administratively feasible. Alternative 2 consists of implementing LUCs at the MRS. The OHARNG currently manages LUCs at other areas at CJAG and MRS-specific LUCs would not be difficult to implement. Alternative 3 would require specialized equipment and personnel to implement. The excavation of MC contaminated soils at the MRS under Alternative 3 should be able to be implemented with appropriate planning and coordination and the services and equipment are readily available; however, it is not as easily implemented as Alternatives 1 and 2.

Cost – The progression of present-worth costs from the least expensive to most expensive alternative is as follows:

- Alternative 1 – No Action – $0;
- Alternative 2 – Land Use Controls – $125,904; and
- Alternative 3 – Complete MC contaminated soil removal (UU/UE) – $587,690

Alternative 1 does not have capital or O&M costs. The capital costs for Alternative 2 has the lowest capital costs. The costs associated with Alternative 3 are the highest among the alternatives, but allows for UU/UE for the Industrial Receptor and Residential Receptor at the MRS.

State Acceptance - This criterion will be evaluated during incorporation of regulatory review comments into this FS and during the future submittals of the Proposed Plan and ROD.

Community Acceptance - This criterion will be further evaluated when the Proposed Plan is presented to the public for review and comment.

6.2 Overall Evaluation

The RI confirmed the presence of MC in soil presenting a risk to a potential future Residential Receptor (See Section 2.4). Although the current and future receptor at the MRS is the Industrial Receptor and the land use is not anticipated to change in the future, the Residential Receptor was evaluated for a conservative approach to achieve UU/UE conditions after remediation. The NCP statutory preference for reduction of toxicity, mobility, or volume through treatment is best achieved with Alternative 3 that allows for UU/UE. Based on the evaluation of NCP criteria Alternative 2 (LUCs) and Alternative 3 (Complete MC Contaminated Soil Removal [UU/UE]) appear to be acceptable and plausible to implement. The deciding factor will be the alternative that best meets the RAOs and is technically and administratively implementable.

Using the comparative analysis of the alternatives presented in this FS, a preferred alternative will be presented to the public in the Proposed Plan for this MRS for review and comment. A remedy will then be selected for this MRS and be presented in the ROD. Table 6-1 provides a summary of the detailed analysis of alternatives in comparison to the nine NCP criteria.

6.3 Munitions Response Site Prioritization Protocol

The DoD proposed the Munitions Response Site Prioritization Protocol (MRSPP) (32 CFR Part 179) to assign a relative risk priority to each MRS in the MMRP Inventory. The MRSPP is a funding mechanism typically performed during the Preliminary Assessment/SI stage to prioritize funding for MRSs on a priority scale of 1 to 8 with a Priority 1 being the highest relative priority with alternate ratings of Evaluation Pending, No Known or Suspected Hazard, or No Longer Required. The overall conditions at the MRS are evaluated, taking into consideration various factors related to explosive safety and environmental hazards. As provided in the RI Report the MRSPP was evaluated and an MRSPP priority of 4 was assigned (CB&I, 2015). This priority was based on the inputs for the Explosives Hazards Exposure (EHE) Module in the MRSPP that the MD found at the MRS during the RI represented physical evidence for potential MEC, along with confirmed MEC found historically. During development of the FS the findings of the RI were further evaluated, and the project team determined that the MEC items identified historically at the MRS are not representative of the explosive hazards at the MRS, as demonstrated by the RI. As a result, the MRSPP was revised and the Group 8 MRS was assigned a score of 5. The revised MRSPP is provided in Appendix C.

Table 6-1 Comparison of Alternatives

CERCLA Evaluation Criteria	Remedial Alternatives		
	Alternative 1 No Action	Alternative 2 LUCs	Alternative 3 MC Contaminated Soil Removal (UU/UE)
Protective of Human Health and Environment	No	No	Yes
Complies with ARARs	Yes	Yes	Yes
Effective and Permanent	No	No	Highest
Reduces Toxicity, Mobility, or Volume	None (no treatment)	None (no treatment)	Removal of MC to achieve UU/UE
Short-Term Effectiveness	Low	Medium	Low
Implementable	Easy to implement	Easy to implement	Most difficult to implement
Costs			
Capital	$0	$20,445	$587,690
O&M (discounted)	$0	$77,608	$0
Periodic (discounted)	$0	$27,851	$0
Present Worth (Capital + discounted O&M +discounted Periodic Costs)	$0	$125,904	$587,690
Five-Year Reviews (discounted)	$0	$94,175	$0
State Acceptance	To be determined		
Community Acceptance	To be determined		

ARAR denotes applicable or relevant and appropriate requirement.
CERCLA denotes Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
LUC denotes Land Use Control
MC denotes munitions constituents
O&M Operation and Maintenance
UU/UE denotes Unlimited Use/Unrestricted Exposure, Unrestricted (Residential) Land Use following UU/UE

7.0 REFERENCES

Army National Guard (ARNG), 2014. *Final Technical Memorandum: Land Uses and Revised Risk Assessment Process for the Ravenna Army Ammunition Plant (RVAAP) Installation Restoration Program*, *Portage/Trumbull Counties, Ohio*. February.

CB&I Federal Services LLC (CB&I), 2015. *Final Remedial Investigation Report for RVAAP-063-R-01 Group 8 MRS, Version 1.0*. May.

Department of Defense (DoD), 2012. *Manual Number 4715.20: Defense Environmental Restoration Program (DERP) Management*. March.

Engineering-environmental Management, Inc. (e^2M), 2008. *Final Site Inspection Report, Ravenna Army Ammunition Plant, Ohio, Military Munitions Response Sites, Ravenna Army Ammunition Plant, Ohio*. May.

Ohio Army National Guard (OHARNG), 2014. *Integrated Natural Resources Management Plan (INRMP) at the Camp Ravenna Joint Military Training Center*, Portage and Trumbull Counties, Ohio. December

Science Applications International Corporation (SAIC), 2010. *Final Facility-Wide Human Health Cleanup Goals for the Ravenna Army Ammunition Plant Ravenna, Ohio.* March.

Shaw, 2011. *Final Work Plan Addendum for Military Munitions Response Program Remedial Investigation Environmental Services*, Version 1.0, December.

U.S. Army, 2009. *Final United States Army Munitions Response Remedial Investigation/Feasibility Study Guidance.* November.

U.S. Army Corps of Engineers (USACE), 2012. *Final Property Management Plan for the Designated Areas of Concerns and Munitions Response Sites Volume One – Version 1.0, Ravenna Army Ammunition Plant, Ravenna, Ohio.* August.

U.S. Environmental Protection Agency (EPA), 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*. October.

EPA, 1994. *National Oil and Hazardous Substances Pollution Contingency Plan*, 40 CFR Part 300.

EPA, 2000. *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*. July.

EPA, 2003. *Recommendations of the Technical Review Group for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil*. EPA-540-R-03-001. January.

EPA, 2007. Analysis of total food intake and composition of individual's diet based on the USDA's 1994-1996, 1998 continuing survey of food intakes by individuals EPA Report EPA/600/R-05/062F.

EPA, 2016. *Update of the Adult Lead Methodology's Default Baseline Blood Lead Concentration and Geometric Standard Deviation Parameters*. OSWER 9285.6-55. August.

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Appendix A
Institutional Analysis

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Facility-Wide Institutional Analysis for the Former Ravenna Army Ammunition Plant Portage and Trumbull Counties, Ohio

Contract No. W912DR-15-D-0016
Delivery Order No. 0001

Prepared for:

US Army Corps of Engineers.

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March 11, 2019

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Acronyms and Abbreviations

ARNG	Army National Guard
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CJAG	Camp James A. Garfield Joint Military Training Center
DDESB	DoD Explosives Safety Board
DERP	Defense Environmental Restoration Program
DID	Data Item Description
DO	Delivery Order
DoD	Department of Defense
EP	Engineer Pamphlet
FS	Feasibility Study
HGL	HydroGeoLogic, Inc.
IA	Institutional Analysis
LUC	land use control
MC	munitions constituents
MMRP	Military Munitions Response Program
MPPEH	munitions potentially presenting and explosive hazard
MRS	munitions response site
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
OE	ordnance and explosives
Ohio EPA	Ohio Environmental Protection Agency
OHARNG	Ohio Army National Guard
PPE	personal protective equipment
RVAAP	Ravenna Army Ammunition Plant
SARA	Superfund Amendments and Reauthorization Act
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USP&FO	U.S. Property and Fiscal Officer
UXO	unexploded ordnance

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1.0 INTRODUCTION

This Institutional Analysis (IA) report was prepared by HydroGeoLogic, Inc. (HGL) for the U.S. Army Corps of Engineers (USACE), Baltimore District, under Military Munitions Response Program (MMRP) Contract No. W912DR-15-D-0016, Delivery Order (DO) No. 0001. This document has been prepared in accordance with *Final United States Army Military Munitions Response Program: Munitions Response Remedial Investigation/Feasibility Study* [FS] *Guidance* (U.S. Army, 2009); USACE Engineer Pamphlet (EP) 1110-1-24, *Establishing and Maintaining Institutional Controls for Ordnance and Explosives (OE) Projects* (USACE, 2000), U.S. Environmental Protection Agency (USEPA) guidance document USEPA-540-R-09-001, *Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites* (USEPA, 2012), and Data Item Description (DID) MR-100, "Institutional Analysis and Institutional Control Plan." The purpose of the IA report is to identify the government agencies necessary to support the response action to be implemented at the Munitions Response Sites (MRSs) addressed by this DO at the former Ravenna Army Ammunition Plant (RVAAP) in Portage and Trumbull Counties, Ohio. This document is intended to be an appendix to each MRS-specific FS. Please refer to the appropriate FS for additional background information.

1.1 Land Use Controls Evaluation

The typical strategies for addressing the presence of material potentially presenting an explosive hazard (MPPEH) and/or munitions constituents (MC) on an MRS are physical removals, treatment (MC only), and land use controls (LUCs). LUCs are implemented to manage any residual MPPEH/MC hazard remaining at a MRS. LUCs can also be implemented as a stand-alone response without a physical removal or treatment.

LUCs consist of various legal mechanisms, educational and engineering control measures, and construction support actions to minimize the potential MPPEH/MC or other hazards for human receptors at an MRS. Instead of eliminating the MPPEH/MC hazard, a LUC remedial action relies on behavior modification and access control strategies to reduce explosive safety and chemical hazards. There are four categories of LUCs, as described in USEPA-540-R-09-001:

- Proprietary controls are generally created pursuant to state and tribal law to prohibit or restrict activities that may pose a safety hazard. These generally consist of easements and covenants.
- Governmental controls impose restrictions on land use or resource use, using the authority of a government entity. Typical examples of governmental controls include zoning, building codes, and groundwater use regulations.
- Enforcement and permit tools with LUC components are legal tools, such as administrative orders, permits, Federal Facility Agreements, and Consent Decrees that limit certain site activities or require the performance of specific activities (e.g., to monitor and report on LUCs effectiveness). They may be issued unilaterally or negotiated.
- Informational devices provide information or notification to local communities that residual or contained contamination remains. Typical informational devices include state registries of contaminated MRSs, notices in deeds, and tracking systems.

To effectively manage long-term residual hazards from MPPEH/MC, USACE seeks and encourages meaningful stakeholder involvement. Coordination with the Army National Guard (ARNG), Ohio Army National Guard (OHARNG), and Ohio Environmental Protection Agency (Ohio EPA) is essential to identifying MRS-specific objectives for an effective LUC program. This coordination includes conducting an IA. The IA process provides the opportunity to obtain information from and to coordinate with government agencies and other stakeholders in developing and implementing an MRS-specific LUC program. The objectives of an IA are to illustrate the opportunities that exist to implement a LUC program at a specific MRS; identify government agencies having jurisdiction over the MRS; and assess the appropriateness, capability, and willingness of government agencies to assert their control over the MRS. This document has been designed to encompass all MRSs addressed under this DO; therefore, each entity's capability and willingness will not be described in an MRS-specific manner.

1.2 Purpose

The purpose of this IA is to determine whether government agencies and/or non-government entities have jurisdiction over the MRS to implement and maintain LUCs. Although LUCs are a viable alternative for minimizing exposure to potential MPPEH/MC, those entities involved in establishing and maintaining LUCs must be capable and willing to do so for the LUCs to be protective. The IA will aid in the evaluation of LUCs that are a component of the alternatives presented in the FS. More specifically, the objectives of this analysis are as follows:

- Document which agencies or entities have jurisdiction over any affected lands within an MRS;
- Assess the authority, capability, and willingness of each agency or entity to assert control that would protect the community from potential MPPEH/MC hazards;
- Document the obligations, if any, of each agency or entity to protect the surrounding community from associated explosive and/or chemical hazards under the law; and
- Document any interim controls or existing LUCs currently in place at each MRS for the protection of human health from potential MPPEH/MC hazards.

Government agencies and other stakeholders that will be required to support short- and long-term LUCs proposed for the MRSs are described and evaluated in this IA report.

1.3 Hazard Review

This IA has been designed to address the institutional support needs of several MRSs associated with the former RVAAP. The MRSs considered during development of this document are listed in Table 1.1 below. The hazards and recommendations associated with each MRS are located in Sections 1.2 and 1.3 of each MRS specific FS.

Table 1.1
Munitions Response Sites Included

MRS	Identification
Ramsdell Quarry Landfill MRS Area 2 (South)	RVAAP-001-R-01
Ramsdell Quarry Landfill MRS Area 1 (North)	RVAAP-001-R-02
Erie Burning Grounds	RVAAP-002-R-01
Open Demolition Area #2	RVAAP-004-R-01
Fuze and Booster Quarry	RVAAP-016-R-01
40mm Firing Range	RVAAP-032-R-01
Block D Igloo	RVAAP-060-R-01
Group 8 MRS	RVAAP-063-R-01

1.4 Regulatory Background

Existing regulations allow for and/or clarify the implementation of LUCs and the performance of an IA. The regulatory authorities governing the establishment and maintenance of LUCs during munitions response actions include the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA); the National Oil and Hazardous Substances Pollution Contingency Plan (NCP); and the Defense Environmental Restoration Program (DERP). These regulations are summarized in Table 1.2 below.

Table 1.2
Summary of Regulatory Background

Regulation	Year Established	Description
Comprehensive Environmental Responses, Compensation and Liability Act (CERCLA)	1980	Created the framework for funding and remediation of abandoned or uncontrolled hazardous waste sites.
Superfund Amendments and Reauthorization Act (SARA), (Section 211, Chapter 160, Environmental Restoration)	1986 Amendment to CERCLA	Established the Defense Environmental Restoration Program (DERP) to "correct environmental damage" that may endanger human health and the environment.
National Oil and Hazardous Substances Pollution Contingency Plan (NCP), (40 Code of Federal Regulations [CFR] Part 300)	Established through the Clean Water Act in 1972	Further outlined procedures for developing, evaluating, and implementing appropriate response actions based on stakeholder input. The March 1990 revision is the latest version of the NCP. Paragraph 300.120(c) identifies the Department of Defense (DoD) as the removal response authority with respect to incidents involving DoD weapons and munitions.
National Defense Authorization Act, (Public Law 107-107)	2002 Amendment to DERP	Created the Military Munitions Response Program (MMRP). Under MMRP, DoD conducts munitions response actions per CERCLA, the NCP, and applicable federal and state laws. DoD considers reasonably anticipated future land use in the design and implementation of response actions. Involvement of local and state government, and other authorities, is encouraged within the munitions response process.

1.5 Institutional Methodology

This document constitutes the IA for the MRSs identified in Table 1.1. Five elements are considered when assessing the ability of a local, county, or state agency to assist in the implementation or monitoring of a proposed LUC program. These five elements are as follows:

- Jurisdiction – The jurisdiction is the territorial range of authority and is generally defined by geographic boundaries within the city, county, or state. Federal, state, and local government agencies may have jurisdiction within the MRS. The laws governing the existence of the specific agency will convey this jurisdiction. In some areas, several agencies may be involved, depending on the type of LUC or what specific aspect of a LUC is being contemplated.
- Authority – The authority of an institution is the nature and extent of controls available to the institution and its legal ability to enforce these controls in each jurisdiction. Key questions that must be asked regarding the authority exercised by a government agency are listed below.
    - What are the limits of the agency's authority?
    - What is the origin of the agency's authority?
    - How much control is exercised by the agency?
    - Does the agency have enforcement authority?
- Mission – The specific mission of the agency is critical to its ability to implement, enforce, or maintain a LUC program.
- Capability – Even if an agency has the jurisdiction, authority, and mission to be involved in a LUC program, if it does not have the capability, it cannot be an effective partner. In the case of local government agencies, the capabilities may be unique and are often a reflection of the desires of the local community. The capabilities of a government or private agency can be augmented; however, this may be subject to fiscal law or budgetary constraints.
- Desire – The desire of a government or private agency to participate in a LUC program is critical to its success. The effectiveness of LUCs is increased when local officials are convinced that participation in a LUC program is in their best interest. Resources in the form of funding for the agency's implementation efforts can help the agency overcome its initial hesitancy to become involved.

1.6 Institutional Selection

The former RVAAP, now known as the Camp James A. Garfield Joint Military Training Center (CJAG), is located in northeastern Ohio within Portage and Trumbull Counties. The facility is approximately 3 miles east/northeast of the City of Ravenna and 1 mile north/northwest of the City of Newton Falls. The facility, approximately 11 miles long and 3.5 miles wide, is bounded by the Norfolk Southern Railroad to the north; State Route 5, the Michael J. Kirwan Reservoir, and the CSX System Railroad to the south; State Route 534 to the east; and Garret, McCormick, and Berry Roads to the west. In addition, the facility is surrounded by the communities of Windham, Garrettsville, Charlestown, and Wayland.

Administrative accountability for the entire 21,683-acre facility was transferred in 2013 to the U.S. Property and Fiscal Officer (USP&FO) for Ohio (the property owner), which subsequently licensed the property to

OHARNG to use for military training. The owner of CJAG and the MRSs included in this IA is the USP&FO for Ohio. The RVAAP restoration program involves cleanup of former production/operational areas throughout the facility related to former munitions plant activities.

Institutions were selected for this IA based on their potential ability to have jurisdiction and authority to implement and maintain LUCs within the facility, or their having a specific mission to protect the public from potential MPPEH/MC hazards. The institutions selected for evaluation are the USP&FO, OHARNG, ARNG, Ohio EPA, and USACE.

A summary of LUC options available for the MRSs addressed under this DO is provided in Section 2.0. During preparation of the IA, USP&FO, OHARNG, ARNG, Ohio EPA and USACE provided information to address items/questions presented in Section 3.0. Representatives of these stakeholders were interviewed by telephone or contacted by email to obtain their perspective and feedback on existing and potential future LUCs. The current and future activities anticipated for the applicable MRSs are presented in Table 1.3.

Table 1.3
MRS Current and Future Land Use

MRS	Current Land Use	Future Land Use
Ramsdell Quarry Landfill	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.
Erie Burning Grounds	Maintenance, natural resource management, and sampling	Fire suppression
Open Demolition Area #2	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.
Fuze and Booster Quarry	Maintenance, natural resource management, and sampling	Military training
40mm Firing Range	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training that may include construction activities is possible.
Block D Igloo	Military training, maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.
Group 8 MRS	Maintenance, natural resource management, and sampling	No changes anticipated; however, future military training possible.

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2.0 LAND USE CONTROLS

This section summarizes LUC options available for the applicable MRSs. LUCs protect property owners, and other workers or personnel, from potential hazards by warning them of their existence and/or limiting access to, or use of, the MRS. LUCs can include legal mechanisms, engineering controls, and educational controls. However, the effectiveness of LUCs depends on the support, involvement, and willingness of local agencies, stakeholders, and landowners to enforce and maintain them. The following subsections describe types of LUCs in detail; however, not all LUCs are appropriate for the MRSs at CJAG. No LUCs are currently enforced at the MRSs, but interim controls have been established while these MRSs are being investigated. Table 2.1 presents the interim controls previously established and the LUC options that could be implemented at the Group 8 MRS. Table 4.1 in Section 4.0 presents the current and potential future controls for each MRS addressed under this DO.

Table 2.1
Interim Controls Previously Established and LUC Options

MRS	Interim Controls Currently in Place		Land Use Control Options
	Educational Controls	Engineering Controls	
Group 8 MRS	Annual training for all employees	Siebert Stakes and Signage around	Educational Controls Engineering Controls to include Siebert Stakes and Signage
	Contractor training as needed upon worker entry to the MRS	None	Annual Inspections
	National Guard training as needed upon trainee in-brief to CJAG	None	Future Remedial Action

FSs for the other MRSs will be submitted separately for review and will also include this IA document.
FS denotes Feasibility Study
IA denotes Institutional Analysis
MRS denotes munitions response site

2.1 Legal Mechanisms

Legal mechanisms limit or control the land use and/or activities that can occur on a property through actions such as deed restrictions, covenants, zoning, permits, and activity requirements/restrictions.

2.1.1 Restrictive Covenants

Restrictive covenants are clauses in property deeds that contractually limit how owners can use the property. Private restrictive covenants are different than zoning ordinances. If the restrictive covenant forbids a use permitted by a zoning ordinance, the restrictive covenant would operate to encumber the property to prohibit the restricted use(s). On the other hand, if the zoning ordinance is more restrictive than the restrictive covenant, the zoning ordinance would take precedence. Restrictive covenants are not applicable to these MRSs as they are within a federal facility. Deed restrictions or covenants will not be put into place at CJAG, as the landowner is the USP&FO for Ohio.

2.1.2 Zoning

Zoning consists of land use or activity restrictions within a specified area as established by a governmental entity (usually a local government such as a municipality or county). The zoning requirements can specify the type of land use (e.g., rural, residential, business, etc.) and can provide specific requirements such as building sizes, setbacks, and street and parking provisions.

2.1.3 Dig Permit System

A dig permit system similar to that for a building permit may be established. A dig permit system can document who is performing the work and the extent and purpose of the digging activity. The permit may require workers to review and sign off on information provided to them about the potential for encountering MPPEH/MC and to comply with established protocols for soil/sediment disturbance activities in potential MPPEH/MC areas. Implementing a dig permit system can require establishing an authority to administer and enforce the permits. A dig permit system requires establishing rules on the type and extent of digging that would require obtaining a permit. Costs for the dig permit system would include initial program setup and then annual administration. There are no currently funded construction projects for these MRSs. The facility manages digging activities within existing procedures and does not support the implementation of an MPPEH/MC specific dig permit system. Therefore, a separate dig permit system specific to these MRSs is not applicable.

2.1.4 Contractor Control Policies

Contractor control policies are written procedures that dictate how contractors who work at an MRS with LUCs will be trained and monitored. They are generally MRS-specific and tailored to the potential hazards present, as well as to the ability of the governing authorities to perform the monitoring. The facility manages contractors that access these MRSs within existing procedures and does not support the implementation of additional MPPEH/MC specific control policies; therefore, contractor control policies specific to these MRSs are not applicable.

2.1.5 Construction Support

Construction support is an effective method to allow site activities to continue safely in areas with potential MPPEH/MC hazards. Construction support can be accomplished in one of two ways: stand-by or on call. Stand-by support is having unexploded ordnance (UXO)-qualified personnel on site during soil/sediment disturbance activities. The UXO personnel would be available to immediately identify any unknown items recovered and make appropriate disposition decisions for those items.

On-call support does not require stationing qualified UXO personnel on site for immediate access. On-call support can be off-site Explosive Ordnance Disposal responders or a UXO contractor available for response as needed. This option includes a site worker MPPEH safety training element, is cost effective, and is deemed appropriate for soil/sediment disturbance activities taking place at the MRSs.

Construction support activities are available to CJAG to support funded construction projects facility-wide. Therefore, there is no reason to create a construction support activity on an MRS-specific basis. Additionally, there are no currently funded construction projects for the MRSs included in this IA; therefore, no construction support or on-call support is recommended as a LUC.

2.1.6 Monitoring

Monitoring at the MRS is a legal mechanism process option that would include visual and physical inspections of the conditions at the MRS and engineered remedial action components, as applicable, and can detect physical changes (e.g., missing signs, unwanted/overgrown vegetation, etc.) that may ultimately lead to the failure or unsatisfactory performance of that component. Repairs and/or revised maintenance activities can be implemented as a result of these inspections. Monitoring would determine the need for repairs and/or replacement of any engineering controls. Exposure hours monitoring is not administratively feasible for occupational hazards to trainees accessing the MRS; however, monitoring of any engineering controls implemented, would be conducted. The appropriate frequency for monitoring would be established to ensure the effectiveness of the remedial alternative and would result in operation and maintenance costs until unlimited use/unrestricted exposure (i.e. negligible MPPEH/MC exposure) is achieved. If applicable, monitoring plans are hazard specific and monitoring occurs as frequently as necessary based on the hazards and MRS characteristics. Examples of monitoring activities include UXO qualified escorts periodically conducting enhanced visual surveys. These activities ensure early identification and response for any material documented as an explosive hazard or identification of any changes to the MRS (i.e. standing water) that would affect the mobility of MC to other environmental media. Exposure hours monitoring is not administratively feasible for occupational hazards to trainees accessing the MRS; however, monitoring will be applied for any LUCs implemented for the MRSs included in this IA.

2.2 Engineering Controls

Engineering controls are physical structures that warn of hazards or prevent access to an MRS. The most probable structures for implementation at the former RVAAP MRSs are fencing, signage, and land covers.

2.2.1 Fencing

Fences are used to restrict public access to an MRS that contains a potential public hazard. Fences are appropriate for areas where MPPEH/MC may be present and where public access would result in potential exposures. Fences require inspection, maintenance, and repair to remain effective. Based on the CJAG mission to use the MRSs for National Guard training; no fencing of the MRSs is preferred. However, the use of fencing will be evaluated for each MRS dependent upon identified hazards. The use of fencing will be applied on an MRS-specific basis.

2.2.2 Signage

Warning signs can be used to notify and inform the public of a potential hazard on a MRS. Such signs would state the nature of the potential MPPEH/MC hazard, how to avoid the hazard, and whom to contact for additional information. Warning signs may be used in conjunction with fencing or may be used as a stand-alone measure where fencing is not an option. Signage may be applicable to an MRS and will be recommended on an MRS-specific basis.

2.2.3 Seibert Stakes

Seibert stakes are posts with red and yellow reflector markings indicating the boundary of a specific area. The stakes are typically used within military training areas to mark the boundaries of sensitive, hazardous, or contaminated areas that are off limits to training or maneuver activities. Siebert stakes have been installed on some of the included MRSs and are currently in use as an interim control. Continued use of Siebert stakes as a future LUC will be evaluated on an MRS-specific basis.

2.2.4 Security Patrols

The patrolling of an MRS by a security officer can ensure that unauthorized personnel do not enter an area with explosive or chemical hazards. This control can be implemented alone or in conjunction with other LUCs to ensure that all established LUCs are enforced. As the entire CJAG facility is patrolled, no additional MRS-specific security patrols are applicable to the MRSs included in this IA.

2.3 Educational Controls

Educational controls can include programs geared toward notification of existing conditions, existing engineering controls, and potential hazards to visitors, CJAG personnel, contractors, and utility workers. Examples of educational controls include public information meetings, printed materials (e.g., information displays and flyers), training for potential receptors (e.g., LUC awareness, recognition, and reporting procedures), and websites to inform property users of the potential presence of MPPEH. Educational controls can be implemented to provide informational materials on potential MPPEH recognition, avoidance, and encounter protocols. For MC risks, educational materials would include information on personal protective equipment (PPE) (rubber booties, nitrile gloves, etc.) and decontamination procedures (washing clothes, shoes, exposed skin, etc.) to prevent accidental ingestion on dermal contact with MC contaminated soil. The use of educational controls (annual training for employees, National Guard trainee in-briefings, and contractors/site workers trained before they access the MRS) is already being implemented by CJAG. Continued use of educational controls with the addition of proper PPE and decontamination procedures, will be evaluated on an MRS-specific basis.

3.0 INSTITUTIONAL SUMMARIES

The following subsections describe the jurisdiction, authority, mission, and potential role in a LUC program of each institution selected for analysis.

3.1 U.S. Property and Fiscal Officer

A USP&FO, as established in Title 32 U.S. Code 708, is a "qualified commissioned officer of the National Guard of that jurisdiction…". A USP&FO is selected by the governor of each state, the Commonwealth of Puerto Rico, Guam, and the U.S. Virgin Islands. The USP&FO is responsible for any receipt or return of funds and/or National Guard property under the jurisdiction of the USP&FO's state. The ownership of CJAG was transferred to the USP&FO for Ohio through several transactions between 1999 to 2013. The USP&FO then licensed the property to OHARNG for use as a military training facility. Through this transaction, the USP&FO has delegated all LUCs implementation authority to OHARNG. Additional information regarding the USP&FO is provided in Table 3.1.

Table 3.1
U.S. Property and Fiscal Office Institutional Summary

Origin of Institution	Title 32 U.S. Code 708 and DoD Instruction 1200.18
Basis of Authority	The authority of USP&FO is recognized by the State of Ohio under Title 32 U.S. Code 708 and DoD Instruction 1200.18
Sunset Provisions	None
Geographic Jurisdiction	The geographic jurisdiction of the Ohio USP&FO includes any ARNG property under their administrative power within the State of Ohio. The USP&FO has geographic jurisdiction for the 21,683 acres within CJAG under License No. DACA27-3-06-013.
Public Safety Function	None
Land Use Controls	Under License No. DACA27-3-06-013, USP&FO delegated to the State of Ohio/ OHARNG the authority to comply with applicable environmental protection laws, which include LUCs.
Financial Capability	None
Desire to Participate	Not applicable
Constraints to Institutional Effectiveness	Under the provisions of the Ravenna License No. DACA27-3-06-013 and the National Guard Regulation 130-6, the OHARNG has financial capability and authority for LUCs.

3.2 Ohio Army National Guard at the Camp James A. Garfield Joint Military Training Center

After munitions production at RVAAP ceased, the accountability for the property was transferred to the Ohio USP&FO in several transfers from 1999 to 2013. The property was renamed "Camp James A. Garfield Joint Military Training Center" and is known as Camp James A. Garfield. CJAG is licensed to OHARNG for use as a military training facility.

OHARNG was established through the Militia Law of 1803 as one of the first acts of Ohio's statehood. OHARNG is comprised of soldiers who train bimonthly and otherwise lead civilian lives until they are called to serve (OHARNG, 2016). OHARNG is a state militia under the control of the Governor of Ohio until called to federal service by the President of the United States. The authority of the OHARNG to implement, maintain, and enforce LUCs at CJAG has been established under License No. DACA27-3-06-013.

Additionally, OHARNG's use of CJAG incentivizes it to provide a safe working and training environment for OHARNG personnel and trainees.

Access to CJAG is limited; however, once authorized visitors are on the property, physical access to the MRSs is unrestricted. Additional information regarding OHARNG at CJAG is provided in Table 3.2.

Table 3.2
Ohio Army National Guard Institutional Summary

Origin of Institution	The Northwest Territory militia was established as OHARNG, an Ohio state militia, in 1803.
Basis of Authority	The USP&FO for Ohio has delegated all LUC implementation authority to OHARNG under License No. DACA27-3-06-013.
Sunset Provisions	None
Geographic Jurisdiction	The geographic jurisdiction of OHARNG is limited to the State of Ohio unless the entity is called upon for federal service by the President of the United States. OHARNG has jurisdiction over multiple military training facilities, including CJAG.
Public Safety Function	OHARNG has public safety functions including: management of safety procedures on CJAG; the authority to implement LUCs at CJAG; and the interim controls established to protect personnel on CJAG.
Land Use Controls	OHARNG is willing to implement, maintain, and enforce the LUCs listed in Table 4.1., once ARNG provides funding and approval.
Financial Capability	Funding for LUCs at CJAG is provided through the Installation Restoration Program, established under DERP and applicable for all ARNG facilities.
Desire to Participate	OHARNG is willing to implement the LUCs as summarized in Table 4.1, once ARNG provides approval.
Constraints to Institutional Effectiveness	OHARNG does not have financial capability to implement LUCs at CJAG. ARNG (See Section 3.3) has the financial capability to implement LUCs. These two entities work in coordination but OHARNG must obtain approval from ARNG for implementation of LUCs.

3.3 Army National Guard

In 1636, ARNG was designated as the first North American militia group to protect colonists from hostile attacks. The militia was established through the Massachusetts Bay Colony's General Court and has been recognized and preserved by the Militia Acts of 1792 and 1903, and by the National Defense Act of 1916 (ARNG, 2016). This entity is characterized by a dual federal and state status unique to ARNG. ARNG members work primarily in their home states preparing for federal response actions as called upon by the President of the United States. ARNG is not the same agency as OHARNG; ARNG is a federal militia established to respond to national emergencies or wartime needs in coordination with the U.S. Military.

The OHARNG and ARNG work in coordination; therefore, through the OHARNG License No. DACA27-3-06-013, the ARNG has authority to effectively maintain and enforce LUCs at CJAG. However, the ARNG has delegated this authority to the OHARNG for specific purposes of LUC enforcement at CJAG. Additional information regarding ARNG is provided in Table 3.3.

Table 3.3
Army National Guard Institutional Summary

Origin of Institution	ARNG was established in December 1636 as the first North American militia group through the Massachusetts Bay Colony's General Court. The Militia Acts of 1792 and 1903, and the National Defense Act of 1916 recognized the militia as a national defense group known today as ARNG.
Basis of Authority	The authority of ARNG is based in the U.S. Government. Specific authority is assigned to ARNG for CJAG under the following: Ravenna License No. DACA27-3-06-013 to the OHARNG and National Guard Regulation 130-6
Sunset Provisions	None
Geographic Jurisdiction	The geographic jurisdiction of ARNG includes the United States and its territories for services as called upon by the President of the United States.
Public Safety Function	The ARNG provides a public safety service by providing funding and approval for LUCs at CJAG.
Land Use Controls	The OHARNG and the ARNG has authority to implement, maintain, and enforce LUCs at CJAG through License No. DACA27-3-06-013.
Financial Capability	ARNG receives funding from the U.S. Government and has the financial capability to maintain and enforce LUCs throughout the property.
Desire to Participate	ARNG is willing to implement the LUCs as summarized in Table 4.1.
Constraints to Institutional Effectiveness	ARNG provides funding for LUCs at CJAG. The ability to provide funding is affected by budget changes over time, limiting funding for specific CJAG projects.

3.4 Ohio Environmental Protection Agency

Ohio EPA was established by the State of Ohio in 1972 by merging several environmentally focused state departments and was tasked with providing clean air and water to the people of Ohio. Ohio EPA establishes and enforces air, water, and waste management standards throughout the State of Ohio. Ohio EPA also provides public educational and pollution prevention programs to minimize the effects of pollution (Ohio EPA, 2016).

Ohio EPA has regulatory authority in the geographical area of CJAG and has coordinated with the USACE, Baltimore District, and OHARNG to ensure that appropriate LUCs will be implemented at the RVAAP MRSs. The ability of Ohio EPA to monitor maintenance needs and enforce the LUCs at CJAG would depend on its willingness to maintain communications with CJAG personnel. Additional information regarding Ohio EPA is provided in Table 3.4.

Table 3.4
Ohio Environmental Protection Agency Institutional Summary

Origin of Institution	Ohio EPA was established on October 23, 1972.
Basis of Authority	The regulatory authority of Ohio EPA to establish and enforce environmentally protective regulations is granted by the State of Ohio. Although CJAG is a federally owned property the Ohio EPA has regulatory authority and will continue to coordinate with OHARNG (by review and concurrence to documents) to ensure appropriate LUCs are established.
Sunset Provisions	None
Geographic Jurisdiction	The geographic regulatory authority for Ohio EPA includes the State of Ohio.
Public Safety Function	The Ohio EPA has the regulatory authority to establish and enforce laws and regulations that protect against human health and environmental concerns. The public safety function of the Ohio EPA at CJAG is accomplished through the coordination with CJAG (by review and concurrence to documents) to establish appropriate LUCs.
Land Use Controls	As a regulatory authority, Ohio EPA may review and concur with the LUCs presented in the FS, Proposed Plan, and Decision Documents.
Financial Capability	None
Desire to Participate	Ohio EPA is willing to provide review and concurrence to LUCs proposed by ARNG.
Constraints to Institutional Effectiveness	As a stakeholder, Ohio EPA may participate in the development of LUCs for the CJAG MRSs and provide review and concurrence. However, Ohio EPA is unable to provide funding for LUC implementation and maintenance.

3.5 U.S. Army Corps of Engineers

USACE provides technical and project management support on environmental and MMRP projects at CJAG and has jurisdiction over munitions response work at the MRSs. The USACE, Baltimore District, works in coordination with the USACE, Louisville District, ARNG, and OHARNG/CJAG. USACE Baltimore District provides the technical expertise and serves as a technical resource for MMRP guidance and DoD guidance applicable to a munitions response site. Additional information regarding USACE is provided in Table 3.5.

Table 3.5
U.S. Army Corps of Engineers Institutional Summary

Origin of Institution	USACE was established in 1775 to provide construction and engineering support to the U.S. Government. In the 1880s, Congress also provided USACE with authority over dumping and dredging in harbors and waterways. With the formation of DERP in 1983, USACE began providing technical and project management support on environmental and MMRP projects.
Basis of Authority	USACE conducts munitions response actions under CERCLA, as amended by SARA, Executive Orders 12580 and 13016, and the safety requirements of the DoD Explosives Safety Board (DDESB). USACE has project-specific management and technical oversight authority on Army MMRP projects.
Sunset Provisions	None
Geographic Jurisdiction	USACE has nine regional divisions that include all of the U.S., the Pacific, Europe, the Middle East, and Afghanistan. USACE provides MMRP project oversight for CJAG through USACE, Baltimore District, technical staff.
Public Safety Function	USACE executes contracts for FSs, Proposed Plans, and Decision Documents to identify appropriate LUCs for MRSs. Additionally, USACE ensures these LUCs are implemented by the landowners and that they are protective of human health and the environment.
Land Use Controls	As technical advisor to the Army, USACE influences the development and selection of LUCs and ensures the implementation of the chosen controls.
Financial Capability	USACE could administer a LUC design or maintenance/oversight contract if programmed and funded by DoD or ARNG.
Desire to Participate	USACE is willing to support ARNG/CJAG in the development of a LUC program.
Constraints to Institutional Effectiveness	USACE coordinates with OHARNG personnel for establishing LUCs; however, USACE does not have the ability to directly implement, maintain, or enforce LUCs once established. USACE only acts in a design/development role at the will of the entities discussed above.

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4.0 EVALUATION OF EXISTING AND POTENTIAL CONTROLS

This section provides an evaluation of existing and potential LUCs discussed in Section 2.0 using the institutional information presented in Section 3.0.

4.1 Evaluation of Existing Controls

CJAG is an access controlled facility; however, within the facility access to the MRSs is unrestricted. Interim controls have been established at some of the MRSs addressed in this IA. The purpose of the interim controls is to temporarily reduce hazards while long-term solutions are identified, evaluated, and established. These temporary measures include reflective Siebert stakes and signs indicating that there are hazards within the MRS. Table 4.1 lists the interim controls present at each MRS addressed by this IA.

Another interim control currently used is educational controls in the form of training (LUC Awareness Training) conducted with National Guard trainees, CJAG full-time workers, and other contractors or visitors to the MRSs. This training provides an overview of the Property Management Plan and the procedures for recognizing and avoiding munitions.

The LUC Awareness Training currently conducted as an interim control (See Table 4.1, "Educational Controls") indicates that the explosive hazards and potential MC risks are effectively mitigated by the interim controls currently in place at the noted MRSs. Based on the effectiveness of the interim controls and the future land use, it is anticipated that the potential controls will continue to effectively mitigate explosive hazards. The OHARNG personnel are trained to deal with MPPEH avoidance, reporting procedures, and MC risks as a part of the LUC Awareness Training. The OHARNG supports the current and potential controls listed in Table 4.1 and the controls will provide adequate protection of human health and the environment.

4.2 Evaluation of Potential Controls

OHARNG has the authority to implement, maintain, and monitor LUCs within the MRSs. Therefore, potential future controls for the MRSs were discussed with representatives from OHARNG and the CJAG Environmental Office. Based on these conversations, it was determined that the LUCs described in Table 4.1 are appropriate for the specific hazards present in each MRS. The ongoing awareness training conducted per the Property Management Plan should continue for all MRSs to ensure that the receptors identified in the FS for each MRS are aware of the controls in place. It was determined that the LUCs listed in Table 4.1 are supported by OHARNG and ARNG for implementation at the MRS as indicated.

Table 4.1
Interim and Potential LUCs

MRS	Interim Controls Currently in Place		Potential Land Use Controls
	Educational Controls	Engineering Controls	
Ramsdell Quarry Landfill	• Annual training for all CJAG employees • Contractor training as needed upon worker entry to the MRS • National Guard training as needed upon trainee in-brief to CJAG	Siebert Stakes and Signage	Educational Controls
Fuze and Booster Quarry		Siebert Stakes and Signage	Educational Controls
Erie Burning Grounds		Siebert Stakes and Signage	Educational Controls
40mm Firing Range		Siebert Stakes and Signage (at former impact area only)	Educational Controls and Annual Inspections
Open Demolition Area #2		Gate at entrance road, Siebert Stakes, and Signage (Siebert Stakes only along the west and south perimeter)	Educational Controls and Engineering Controls
Block D Igloo		None	Educational Controls and Engineering Controls
Group 8 MRS		Siebert Stakes and Signage	Educational Controls and Engineering Controls

Note:
Bold/Highlighted text identifies the applicable MRS Feasibility Study to which this IA is appended.
Feasibility studies for the other MRSs will be submitted separately for review and will also include this IA document.

5.0 REFERENCES

Data Item Description (DID) MR-100, 2003. "Institutional Analysis and Institutional Control Plan."

Ohio Army National Guard (OHARNG), 2016. Ohio National Guard History. Accessed December 6, 2016. http://www.ong.ohio.gov/information/history/history_index.html.

Ohio Environmental Protection Agency (Ohio EPA), 2016. Ohio Environmental Protection Agency: About Us. Accessed December 6, 2016. http://www.epa.state.oh.us/about.aspx.

U.S. Army, 2009. *Final United States Army Military Munitions Response Program: Munitions Response Remedial Investigation/Feasibility Study Guidance*. November.

U.S. Army Corps of Engineers (USACE), 2000. Engineer Pamphlet (EP) 1100-1-24, *Establishing and Maintaining Institutional Controls of Ordnance and Explosive (OE) Projects*, December.

U.S. Army National Guard (ARNG), 2016. National Guard: How We Began. Accessed December 6, 2016. http://www.nationalguard.mil/About-the-Guard/How-We-Began.

U.S. Environmental Protection Agency (USEPA), 2012. USEPA-540-R-09-001, *Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites*. December.

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Appendix B
Feasibility Study Cost Summary Tables

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Table B-1
Alternative 2: Land Use Controls - Cost Summary
Group 8 MRS

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Workplans				
Land Use Control Implementation Plan	Lump Sum	$9,758	1	$9,758
Subtotal				**$9,758**
LUC Implementation				
LUC Awareness Training	Lump Sum	$3,269	1	$3,269
Educational Controls-Briefing Handouts	Lump Sum	$1,788	1	$1,788
Subtotal				**$5,057**
	SUBTOTAL			**$14,815**
	SUPERVISION AND ADMIN @ 8%			$1,185
	CONTINGENCY @ 30%			$4,444
	TOTAL CAPITAL COSTS			**$20,445**
ANNUAL O&M COSTS				
Institutional Controls Maintenance				
Future LUC Awareness Training (Annual)	Lump Sum	$2,796	30	$83,866
Subtotal				**$83,866**
	SUBTOTAL (ANNUALLY)			**$83,866**
	SUPERVISION AND ADMIN @ 8%			$6,709
	CONTINGENCY @ 30%			$25,160
	TOTAL ANNUAL O&M COSTS (30 Years)			**$115,735**
	O&M PRESENT WORTH (2.8%)			**$77,608**
PERIODIC COSTS				
None		$0		$0
Subtotal				**$0**
Site Visits and Enhanced Visual Surveys (Years 5, 10, 15, 20, 25, 30)				
Site Visit and Enhanced Visual Survey	Each	$5,305	6	$31,830
Subtotal				**$31,830**
	SUBTOTAL			**$31,830**
	SUPERVISION AND ADMIN @ 8%			$2,546
	CONTINGENCY @ 30%			$9,549
	TOTAL PERIODIC COSTS (30 Years)			**$43,926**
	PERIODIC PRESENT WORTH (2.8%)			**$27,851**
TOTAL ALTERNATIVE COST (Capital + O&M Present Worth + Periodic Present Worth)				**$125,904**
FIVE-YEAR REVIEWS				
Five Year Reviews (Years 5, 10, 15, 20, 25, 30)				
Five Year Reviews	Each	$17,938	6	$107,630
Subtotal				**$107,630**
	SUPERVISION AND ADMIN @ 8%			$8,610
	CONTINGENCY @ 30%			$32,289
	TOTAL FIVE-YEAR REVIEWS (30 Years)			**$148,529**
	FIVE-YEAR REVIEWS PRESENT WORTH (2.8%)			**$94,175**

Table B-2
Alternative 2: Land Use Controls - Cost Elements
Group 8 MRS

TASK	SUBTASK	TASK DESCRIPTION	LABOR HOURS	LABOR DOLLARS	ODCs	TRAVEL	SUB-CONTRACTORS	SUBTASK TOTAL	TASK TOTAL
1		**Land Use Control Implementation Plan**							**$9,758**
	1.1	Land Use Control Implementation Plan	90	$9,620	$138			$9,758	
2		**LUC Implementation**							**$5,057**
	2.1	LUC Awareness Training	27	$2,800	$469			$3,269	
	2.2	Educational Controls-Briefing Handouts	22	$1,788				$1,788	
3		**LUC Maintenance**							**$2,796**
	3.1	Future LUC Awareness Training (Annual)	28	$1,476	$100	$1,220		$2,796	
4		**Monitoring and 5-Year Review**							**$23,243**
	4.1	Site Visit and Enhanced Visual Survey	52	$2,668				$5,305	
	4.2	5-Year Review Report	180	$17,800	$138	$2,637		$17,938	
		TOTAL	**399.1**	**$36,153**	**$845**	**$3,856**			**$40,854**

[1]Costs for Tasks 3, 4, and 5 are the annual or periodic unit price only and do not represent the total cost over the 30-year performance period.

[2]Costs are not discounted.

Table B-3
Alternative 2: Land Use Controls - Task 1.0 Details
Group 8 MRS

		Subtask 1.1 Land Use Control Implementation Plan		Total	
	Project Rate	**Hours/Qty**	**Dollars**	**Hours/Qty**	**Dollars**
Labor Category (Home Site)					
Corporate Quality Manager	$163.06	8	$1,304	8	$1,304
Senior Project Manager	$163.06	24	$3,913	24	$3,913
Geographic Information Systems (GIS) Specialist	$102.49	10	$1,025	10	$1,025
Junior Environmental Engineer	$77.14	32	$2,468	32	$2,468
Administrative Assistant	$56.79	16	$909	16	$909
TOTAL HOME SITE LABOR		**90**	**$9,620**	**90**	**$9,620**
TOTAL LABOR		**90**	**$9,620**	**90**	**$9,620**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	$23.00	6	$138	6	$138
TOTAL OTHER DIRECT COSTS			**$138**		**$138**
TOTAL COSTS			**$9,758**		**$9,758**

ASSUMPTIONS:

Based on existing interim controls currently in place for all of Camp Ravenna, the Group 8 MRS LUCs will document inclusion of the MRS in the current procedures for LUC Awareness Training already implemented by Camp Ravenna.

The upated Appendix A to the Property Management Plan will document the location of this MRS and document the inclusion of the MRS in required briefings and annual training.

Table B-4
Alternative 2: Land Use Controls - Task 2.0 Details
Group 8 MRS

			Subtask 2.1		Subtask 2.2		Total	
			LUC Awareness Training		Educational Controls-Briefing Handouts			
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)								
Senior Project Manager		$163.06	8	$1,304	2	$326	10	$1,631
Geographic Information Systems (GIS) Specialist		$102.49	2	$205			2	$205
Junior Environmental Engineer		$77.14	16	$1,234	16	$1,234	32	$2,468
Administrative Assistant		$56.79	1	$57	4	$227	5	$284
TOTAL HOME SITE LABOR			**27**	**$2,800**	**22**	**$1,788**	**49**	**$4,588**
TOTAL LABOR			**27**	**$2,800**	**22**	**$1,788**	**49**	**$4,588**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	package	$23.00	3	$69			3	$69
Printing	each	$200.00	2	$400			2	$400
TOTAL OTHER DIRECT COSTS				**$469**				**$469**
TOTAL COSTS				**$3,269**		**$1,788**		**$5,057**

ASSUMPTIONS:

The original LUC Awareness Training materials will be developed as part of the Property Management Plan, Appendix A.

Subtask 2.1, will include any revisions required for specific materials related to the Group 8 MRS or updates to the Property Management Plan materials.

Subtask 2.2, Educational Controls-Briefing Handouts will include any additional revisions required to handouts or sign-in sheets, specific to the Group 8 MRS.

Table B-5
Alternative 2: Land Use Controls - Task 3.0 Details
Group 8 MRS

			Subtask 3.1 Future LUC Awareness Training (Annual)		Total	
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Field Site)						
Community Relations Specialist		$53.22	18	958	18	958
Administrative Assistant (OT)		$51.29	10	518	10	518
TOTAL FIELD SITE LABOR			**28**	**$1,476**	**28**	**$1,476**
TOTAL LABOR			**28**	**$1,476**	**28**	**$1,476**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
Printing			1	$100	1	$100
TOTAL OTHER DIRECT COSTS				**$100**		**$100**
TRAVEL				**$1,220**		**$1,220**
TOTAL COSTS				**$2,796**		**$2,796**

ASSUMPTIONS:
Subtask 3.1 covers two days of training provided by a community relations specialist for any specific briefings necessary for this MRS, travel costs to mobilize, and printing of briefing materials.

The original version of the LUC Awareness Training materials will be developed as part of the Property Management Plan Appendix A.

The total costs presented is the annual unit price only and does not represent the total cost over the 30-year performance period.

Table B-6
Alternative 2: Land Use Controls - Task 4.0 Details
Group 8 MRS

		Subtask 4.1		Subtask 4.2		Total	
		Site Visit and Enhanced Visual Survey		5-Year Review Report			
	Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)							
Senior Project Manager	$163.06	2	$326	32	$5,218	34	$5,544
Geographic Information Systems (GIS) Specialist	$102.49			16	$1,640	16	$1,640
Senior Environmental Engineer	$163.06			20	$3,261	20	$3,261
Junior Environmental Engineer	$77.14			70	$5,400	70	$5,400
Administrative Assistant	$56.79	2	$114	32	$1,817	34	$1,931
TOTAL HOME SITE LABOR		**4**	**$440**	**170**	**$17,336**	**174**	**$17,776**
Labor Category (Field Site)							
Junior Chemist	$46.43	24	$1,114			24	$1,114
Junior Geologist	$46.43	24	$1,114	10	$464	34	$1,579
TOTAL FIELD SITE LABOR		**48**	**$2,229**	**10**	**$464**	**58**	**$2,693**
TOTAL LABOR		**52**	**$2,668**	**180**	**$17,800**	**232**	**$20,469**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	$23.00			6	$138	6	$138
TOTAL OTHER DIRECT COSTS					**$138**		**$138**
TRAVEL			**$2,637**				**$2,637**
TOTAL COSTS			**$5,305**		**$17,938**		**$23,243**

ASSUMPTIONS:
Subtasks 4.1 and 4.2 cover monitoring and CERCLA Five-Year Reviews that will occur in Years 5, 10, 15, 20, 25 and 30.

The total costs presented is the annual unit price only and does not represent the total cost over the 30-year performance period.

Table B-7
Group 8 MRS
5-Year Reviews

COST ELEMENTS						
	LABOR HOURS	LABOR DOLLARS	ODCs	TRAVEL	SUBTASK TOTAL	TASK TOTAL
Monitoring and 5-Year Review						**$23,243.40**
Site Visit and Enhanced Visual Survey	52.00	2,668.34		$2,636.72	$5,305.06	
5-Year Review Report	180.00	17800.34	138		$17,938.34	
TOTAL FIRM FIXED PRICE	**232.00**	**20,468.68**	**138.00**	**2,636.72**		**$23,243.40**

Table B-8
Alternative 3: MC Contaminated Soil Removal
(UU/UE) - Cost Summary
Group 8 MRS

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Workplans				
Remedial Action Work Plan	Lump Sum	$57,199	1	$57,199
Remedial Action Report	Lump Sum	$40,592	1	$40,592
Subtotal				**$97,791**
Surface and Subsurface Removal				
Mobilization/Demobilization	Lump Sum	$20,710	1	$20,710
Surveying and Mapping	Lump Sum	$6,736	1	$6,736
Vegetation Clearance and MD Segregation/Inspection	Lump Sum	$20,660	1	$20,660
MC Soils Excavation and Disposal (concurrent w/ M	Lump Sum	$63,054	1	$63,054
MDAS Disposal and MC Characterization Sampling	Lump Sum	$31,194	1	$31,194
MC Waste Disposal Sampling	Lump Sum	$185,717	1	$185,717
Subtotal				**$328,072**
	SUBTOTAL			**$425,862**
	SUPERVISION AND ADMIN @ 8%			$34,069
	CONTINGENCY @ 30%			$127,759
	TOTAL CAPITAL COSTS			**$587,690**
TOTAL ALTERNATIVE COST				**$587,690**

Assumptions:

These costs are for comparison purposes only and have an accuracy of +50% or -30%. Many design variables and necessary activities have not been established.

Table B-9
Alternative 3: MC Contaminated Soil Removal
(UU/UE) - Cost Elements
Group 8 MRS

TASK	SUBTASK	TASK DESCRIPTION	LABOR HOURS	LABOR DOLLARS	ODCs	TRAVEL	SUB-CONTRACTORS	SUBTASK TOTAL	TASK TOTAL
1		**Work Plans**							**97,791**
	1.1	Remedial Action Work Plan	524	$57,061	$138			$57,199	
	1.2	Remedial Action Completion Report	380	$40,454	$138			$40,592	
2		**Remedial Action: Surface and Subsurface Removal**							**$328,072**
	2.1	Mobilization/Demobilization	112	$7,542	$2,455	$10,713		$20,710	
	2.2	Surveying and Mapping	34	$3,172		$565	$3,000	$6,736	
	2.3	Vegetation Clearance and MD Segregation/Inspection	100	$7,671	$5,495	$7,493		$20,660	
	2.4	MC Soils Excavation and Disposal (concurrent w/ MD Segregation/Inspection)	444	$24,221	$16,812	$22,020		$63,054	
	2.5	MDAS Disposal and MC Characterization Sampling	130	$10,439	$7,403	$6,423	$6,930	$31,194	
	2.6	MC Waste Disposal Sampling	146	$9,479	$934	$10,704	$164,600	$185,717	
		TOTAL	**1,870**	**$160,039**	**$33,376**	**$57,918**	**$174,530**		**$425,862.45**

[1]Costs are not discounted.

Table B-10
Alternative 3: MC Contaminated Soil Removal (UU/UE) - Task 1.0 Details
Group 8 MRS

		Subtask 1.1 Remedial Action Work Plan		Subtask 1.2 Remedial Action Completion Report		Total	
	Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)							
Corporate Quality Manager	$163.06	8	$1,304	8	$1,304	16	$2,609
Senior Project Manager	$163.06	60	$9,784	48	$7,827	108	$17,610
Senior Geophysicist	$163.06	20	$3,261	20	$3,261	40	$6,522
Junior Geophysicist	$102.49	48	$4,920	48	$4,920	96	$9,839
Junior Geologist	$77.14	120	$9,257	60	$4,628	180	$13,885
Certified Industrial Hygienist (CIH)	$163.06	8	$1,304			8	$1,304
Geographic Information Systems (GIS) Specialist	$102.49	24	$2,460	24	$2,460	48	$4,920
Senior Risk Assessor	$163.06	24	$3,913			24	$3,913
Senior Environmental Engineer	$163.06	60	$9,784	40	$6,522	100	$16,306
Junior Environmental Engineer	$77.14	120	$9,257	100	$7,714	220	$16,971
Administrative Assistant	$56.79	32	$1,817	32	$1,817	64	$3,635
TOTAL HOME SITE LABOR		**524**	**$57,061**	**380**	**$40,454**	**904**	**$97,515**
TOTAL LABOR		**524**	**$57,061**	**380**	**$40,454**	**904**	**$97,515**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	$23.00	6	$138	6	138	12	$276
TOTAL OTHER DIRECT COSTS			**$138**		**138**		**$276**
TOTAL COSTS			**$57,199**		**$40,592**		**$97,791**

Table B-11
Alternative 3: MC Contaminated Soil Removal (UU/UE) - Task 2.0 Details
Group 8 MRS

			Subtask 2.1		Subtask 2.2		Subtask 2.3	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Clearance and MD Segregation/Inspection	
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)								
Senior Project Manager		$163.06	16	$2,609			8	$1,304
Senior Geophysicist		$163.06						
Junior Geophysicist		$102.49						
Senior Chemist		$163.06						
Junior Chemist		$77.14						
Administrative Assistant		$56.79			4	$227	12	$681
TOTAL HOME SITE LABOR			**16**	**$2,609**	**4**	**$227**	**20**	**$1,986**
Labor Category (Field Site)								
Senior Chemist		$98.15						
Junior Chemist		$46.43						
Senior Geologist		$98.15	16	$1,570	30	$2,945	40	$3,926
Junior Geologist		$46.43	32	$1,486				
Heavy Equipment Operator **		$36.67	32	$1,173				
UXO Technician II **		$43.98	16	$704			40	$1,759
TOTAL FIELD SITE LABOR			**96**	**$4,933**	**30**	**$2,945**	**80**	**$5,685**
TOTAL LABOR			**112**	**$7,542**	**34**	**$3,172**	**100**	**$7,671**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	package	$23						
EQUIPMENT AND MATERIALS								
Trailer rental	week	$500					1	$500
DGM equipment mobilization	lump sum	$1,500	1	$1,500				
GPS Rover	week	$900						
UTV rental	week	$1,500					1	$1,500
Misc. equipment	month	$3,000					0.25	$750
Pickup truck rental	day	$104					12	$1,248
Pickup truck Fuel/ tank	each	$50					4.00	$200
Office Trailer mobilization	lump sum	$800	1	$800				
Office trailer rental	month	$3,000					0.25	$750
Generator rental	week	$200					1	$200

Table B-11
Alternative 3: MC Contaminated Soil Removal (UU/UE) - Task 2.0 Details
Group 8 MRS

			Subtask 2.1		Subtask 2.2		Subtask 2.3	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Clearance and MD Segregation/Inspection	
Backhoe Rental	week	$1,500						
Sales Tax	6.75%			$155				$347
TOTAL OTHER DIRECT COSTS				**$2,455**				**$5,495**
TRAVEL				**$10,713**		**$565**		**$7,493**
SUBCONTRACTORS:								
Surveyor						$3,000		
MDAS Transportation	lump sum	$2,000						
MDAS Disposal	ton	$800						
Analytical Laboratory / Discrete Samples	sample	$135						
Analytical Laboratory / Investigation Derived Waste Samples	sample	$80						
Loading, Transport and Disposal of MC Contaminated Soils	Ton	$225						
Analytical Laboratory / ISM Samples	sample	$180						
TOTAL SUBCONTRACTORS						**$3,000**		
TOTAL COSTS				**$20,710**		**$6,736**		**$20,660**

Table B-11
Alternative 3: MC Contaminated Soil Removal (UU/UE) - Task 2.0 Details
Group 8 MRS

			Subtask 2.4		Subtask 2.5		Subtask 2.6		Total	
			MC Soils Excavation and Disposal (concurrent w/ MD Segregation/Inspection)		MDAS Disposal and MC Characterization Sampling		MC Waste Disposal Sampling			
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)										
Senior Project Manager		$163.06	12	$1,957	8	$1,304	8	$ 1,304	52	$8,479
Senior Geophysicist		$163.06								
Junior Geophysicist		$102.49								
Senior Chemist		$163.06			8	$1,304			8	$1,304
Junior Chemist		$77.14			12	$926			12	$926
Administrative Assistant		$56.79	12	$681	12	$681	8	$ 454	48	$2,726
TOTAL HOME SITE LABOR			**24**	**$2,638**	**40**	**$4,216**	**16**	**$1,759**	**120**	**$13,435**
Labor Category (Field Site)										
Senior Chemist		$98.15					2	$196	2	$196
Junior Chemist		$46.43					8	$371	8	$371
Senior Geologist		$98.15	70	$6,871	40	$3,926	40	$3,926	236	$23,163
Junior Geologist		$46.43	140	$6,500	40	$1,857			212	$9,843
Heavy Equipment Operator **		$36.67	140	$5,134			40	$1,467	212	$7,774
UXO Technician II **		$43.98	70	$3,079	10	$440	40	$1,759	176	$7,740
TOTAL FIELD SITE LABOR			**420**	**$21,583**	**90**	**$6,223**	**130**	**$7,720**	**846**	**$49,089**
TOTAL LABOR			**444**	**$24,221**	**130**	**$10,439**	**146**	**$9,479**	**966**	**$62,524**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	package	$23	2	$46	3.00	$69			5	$115
EQUIPMENT AND MATERIALS										
Trailer rental	week	$500	3	$1,500	1	$500	0.25	$125	5	$2,625
DGM equipment mobilization	lump sum	$1,500							1	$1,500
GPS Rover	week	$900	1.00	$900	1.00	$900			2	$1,800
UTV rental	week	$1,500	3.00	$4,500	1.00	$1,500			5	$7,500
Misc. equipment	month	$3,000	0.75	$2,250	0.25	$750	0.25	$750	2	$4,500
Pickup truck rental	day	$104	14.00	$1,456	5.00	$520			31	$3,224
Pickup truck Fuel/ tank	each	$50	8.00	$400	5.00	$250			17	$850
Office Trailer mobilization	lump sum	$800							1	$800
Office trailer rental	month	$3,000	0.50	$1,500	0.25	$750			1	$3,000
Generator rental	week	$200	1	$200	1	$200			3	$600

Table B-11
Alternative 3: MC Contaminated Soil Removal (UU/UE) - Task 2.0 Details
Group 8 MRS

			Subtask 2.4		Subtask 2.5		Subtask 2.6		Total	
			MC Soils Excavation and Disposal (concurrent w/ MD Segregation/Inspection)		MDAS Disposal and MC Characterization Sampling		MC Waste Disposal Sampling			
Backhoe Rental	week	$1,500	2	$3,000	1	$1,500			3	$4,500
Sales Tax	6.75%			$1,060		$464		$59		$2,086
TOTAL OTHER DIRECT COSTS				**$16,812**		**$7,403**		**$934**		**$33,100**
TRAVEL				**$22,020**		**$6,423**		**$10,704**		**$57,918**
SUBCONTRACTORS:										
Surveyor										$3,000
MDAS Transportation	lump sum	$2,000					1	$2,000		$2,000
MDAS Disposal	ton	$800					2	$1,600		$1,600
Analytical Laboratory / Discrete Samples	sample	$135			30	$4,050	20	$2,700		$6,750
Analytical Laboratory / Investigation Derived Waste Samples	sample	$80					10	$800		$800
Loading, Transport and Disposal of MC Contaminated Soils	Ton	$225					700	$157,500		$157,500
Analytical Laboratory / ISM Samples	sample	$180			16	$2,880				$2,880
TOTAL SUBCONTRACTORS						**6,930**		**$164,600**		**$174,530**
TOTAL COSTS				**$63,054**		**$31,194**		**$185,717**		**$328,072**

Table B-12
Alternative 3:
MC Contaminated Soil Removal (UU/UE) - Basis of Estimate
Group 8 MRS

2.1 Mobilization/Demobilization

Mobilization/demobilization includes 2 eight-hour days for travel to and from the site. Travel for one Project Manager site visit is included during the duration of the field work event. Staff mobilizations required include: Site Supervisor (Senior Geologist), 2 Heavy Equipment Operators, 1 UXO Technicians II, 2 Junior Geologists. Seven field personnel plus the Project Manager = 8 mobilizations/demobilizations.

2.2 Surveying and Mapping

Task duration is 3 ten-hour work days for the Site Supervisor and the subcontracted surveyor.

2.3 Vegetation Clearing and Construction Support

Labor hours include Project Manager hours for supervision, Administrative staff support for procurement tasks. Each subtask workday is 10 hours. Subtask assumes minimal vegetation removal and site setup (0.5 days). Safety briefings for subcontractors is estimated for 0.5-day. Three (3) additional days are estimated for site restoration and equipment maintenance. Field labor includes the Site Manager and one UXO Technician II for a total of 4 days (40 hours). The MD segregation/inspection includes the UXO Technician II for the duration of the MC soils excavation, soil sampling, and soil disposal activities.

2.4 MC Soils Excavation and Disposal

Labor hours include Project Manager hours for supervision and Administrative staff support for procurement tasks. Each subtask workday is 10 hours. Subtask assumes an average production rate of 0.2 acres per day per foot of depth excavated for (3 days), segregation and inspection of MD and Stockpiling of Soils (4 work days). Field labor includes the Site Supervisor and a UXO Technician II, two Junior Geologists, two Heavy Equipment Operators, and office support personnel. The MC contaminated soil removal will be accomplished when 0.5-foot below ground surface depth is reached (as confirmed by additional laboratory analytical confirmation sampling from the 0.5 ft to 1 ft bgs interval). While the MC contaminated soil removal is accomplished, any MD identified will be inspected, segregated and certified as MDAS for proper disposal offsite.

Table B-12
Alternative 3:
MC Contaminated Soil Removal (UU/UE) - Basis of Estimate
Group 8 MRS

2.5 MDAS Disposal and MC Characterization Sampling

Labor hours include Project Manager hours for supervision and Administrative staff support for procurement tasks. Chemist hours are included for procurement with laboratories and coordination with subcontracted laboratories and data validation and verification of data. Field labor includes the Site Supervisor, a UXO Technician II and a Junior Geologist. Subtask includes one 10-hour day for the UXO Technician II to inspect and certify MDAS for offsite recycling. Sampling for MC includes both ISM samples and discrete samples for confirmation. A total of 2 tons of MDAS is assumed for off-site disposal for recycling. MC confirmation sampling will be conducted to confirm the extent of MC contaminated soil to the established PRGs has been removed. Initial sampling will be collected from the 0.5 feet bgs immediately below the excavated interval (3 days for the Junior Geologist and UXO Technician II). After evaluation of the initial sampling results, follow up discrete samples will be collected from the bottom and sidewalls to confirm all MC contaminated soils that exceed PRGs were excavated and stockpiled (up to 12 discrete samples, one field day). A total of seven field days.

2.6 MC Waste Disposal Sampling and MC Soils Excavation and Disposal

Excavation of 100% of the estimated 533 CY soil volume of the MC contaminated soil is assumed. Approximately 533 CY of soil is anticipated to require stockpiling and management. It is assumed that 100% of stockpiled soils will require offsite disposal as non-hazardous waste (700 tons). Excavation using heavy equipment, management of stockpiled soils, sampling for investigation derived waste criteria, loading and transport for offsite disposal is estimated to require 4 work days, work to be conducted only after MD is segregated from the soils. Rapid turnaround time from laboratories for analytical data is assumed. Hours are included for the Heavy Equipment operator, UXO Technician I and the Site Supervisor (Senior Geologist). Confirmation samples for investigation derived waste (IDW) analytical methods will be collected by the Junior Geologist. Transport and Disposal costs are included for a subcontractor and the appropriate offsite landfill facility disposal fees.

ISM denotes incremental sampling methodology
MC denotes munitions constituents
MD denotes munitions debris
MDAS denotes material documented as safe

Appendix C
Revised MRSPP Scoring Sheets

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Table A

MRS Background Information

DIRECTIONS: Record the background information below for the MRS to be evaluated. Much of this information is available from DoD databases, such as RMIS. If the MRS is located on a FUDS property, the suitable FUDS property information should be substituted. In the MRS summary, briefly describe the UXO, DMM, or MC that are known or suspected to be present, the exposure setting (the MRS's physical environment), any other incidental non-munitions related contaminants found at the MRS (e.g., benzene, trichloroethylene), and any potentially exposed human and ecological receptors. Include a map of the MRS, if one is available.

Munitions Response Site (MRS) Name:	**Group 8 MRS**
Component:	US Army
Installation/Property Name:	**Ravenna Army Ammunition Plant**
Location (City, County, State):	Newton Falls, Portage and Trumbull Counties, Ohio
UTM Coordinates (NAD83):	X = 496687.252403 Y = 4559101.976339
Site Name (RMIS ID):	OH213820736
Project Name (Project No.):	Ravenna Army Ammunition Plant Group 8 MRS (RVAAP-063-R-01) Feasibility Study
Date Information Entered/Updated:	1-Aug-2018
Point of Contact (Name/Phone):	Kimberly Vaughn (254) 228-5616

Project Phase ("X" only one):										
	PA		**SI**		**RI**	**X**	**FS**		**RD**
	RA-C		**RIP**		**RA-O**		**RC**		**LTM**

Media Evaluated ("X" all that apply):				
	Groundwater (human receptor)		**Sediment (human receptor)**
X	**Surface soil (human receptor)**		**Surface water (ecological receptor)**
	Sediment (ecological receptor)		**Surface water (human receptor)**

MRS Summary

MRS Description: Describe the munitions-related activities that occurred at the installation, the dates of operation, and the UXO, DMM (by type of munition, if known) or munitions constituents (by type, if known) known or suspected to be present):

The Group 8 MRS is a 2.65-acre site located between Buildings 846 and 849 just north of the southern Camp Ravenna boundary. The MRS was used for an undetermined amount of time to burn construction debris and rubbish. Although it has not been documented, previous discoveries of MEC and MDAS indicate that the area also received various munitions items which may also have been burned at the MRS. Historical findings on the ground surface of the MRS include one anti-personnel fragmentation bomb (HE) and one demilitarized 175mm projectile (RI Report, Section 1.2). No MEC was identified during the RI intrusive activities; however, 359 individual MDAS items were recovered at depths ranging from 1 inch to 4 feet bgs (RI Report, Section 4.2). MDAS items recovered were classified as expended fuzes, 75mm projectile pieces, 20mm cartridges, inert 40mm HE projectiles, inert HEAT warheads, expended 60mm M49 mortars, ammunitions cans with debris, and unidentifiable MDAS fragments (RI Report, Section 4.2). The RI results were re-evaluated during the FS and it was determined that the historical MEC finds were not consistent with the subsurface MDAS recovered during the RI. No additional explosive hazards are anticipated at the MRS (FS, Section 2.1.1). MC sampling activities were conducted during the RI field work. Site-related chemicals identified at the MRS included 2 explosives, 10 inorganics, 21 SVOCs, and 2 PCBs in surface soil (0 to 0.5-foot bgs) and 8 inorganics, 14 SVOCs, and 2 PCBs in surface soil (4 to 4.5 feet bgs) (RI Report Section 4.3). Subsequent human health and ecological risk assessments determined that there were potential risks associated with MC to receptors (RI Report, Section 7.0 and 8.0).

Description of Pathways for Human and Ecological Receptors:

No explosive hazard was identified at the MRS during the RI and re-evaluation of the RI results during the FS concluded that historical MEC finds on the MRS surface are inconsistent with subsurface MDAS. The project team concluded that no explosive hazard exists at the Group 8 MRS (FS, Section 2.1.1.4). Due to the lack of source, the exposure pathway for ecological receptors at the MRS is considered incomplete. The exposure pathway is incomplete for National Guard Trainees also. Based on the risk management evaluation (FS, Section 2.1.2.5), cadmium in surface soil at GR8SS-004M-0001-SO poses a potential risk to the future Resident Receptor (Adult and Child). Soil contaminants do not pose a potential risk to the Industrial Receptor, who is the representative receptor under current site use. Remediation of the cadmium contamination in GR8SS-004M will eliminate potential risks to human health under Unrestricted (Residential) Land Use.

Description of Receptors (Human and Ecological):

The National Guard Trainee was identified as the representative receptor for the MRS during the RI; however, in accordance with the Technical Memorandum (ARNG, 2014), the human receptor that has the greatest opportunity for exposure to MC at the MRS is the Industrial Receptor. The Industrial Receptor represents a full time occupational receptor at the MRS whose activities are consistent with full-time employees or career military personnel who are expected to work daily at Camp Ravenna over their career (FS, Section 2.1.1.2).

Ecological receptors (biota) have been identified to include terrestrial invertebrates (earthworms), voles, shrews, American Robins, foxes, hawks, and terrestrial plants. The biota consists of mammals and birds known to be present at the RVAAP and based on the MRS physical setting are reasonably anticipated to be present on either a permanent or transient basis at the terrestrial habitats at the Group 8 MRS (RI Report, Section 9.1.2).

Table 1
EHE Module: Munitions Type Data Element Table

Directions: Below are eleven classifications of munitions and their descriptions. Annotate the score(s) that correspond with **all** munitions types known or suspected to be present at the MRS.

Note: The terms *practice munitions*, *small arms*, *physical evidence*, and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
Sensitive	All UXO that are considered likely to function upon any interaction with exposed persons [e.g., submunitions, 40mm high-explosive (HE) grenades, white phosphorous (WP) munitions, high-explosive antitank (HEAT) munitions, and practice munitions with sensitive fuzes, but excluding all other practice munitions].	30	
	All hand grenades containing energetic filler.		
	Bulk primary explosives, or mixtures of these with environmental media, such that the mixture poses an explosive hazard.		
High explosive (used or damaged)	All UXO containing a high-explosive filler (e.g., RDX, Composition B), that are not considered "sensitive."	25	
	All DMM containing a high-explosive filler that have been damaged by burning or detonation, or deteriorated to the point of instability		
Pyrotechnic (used or damaged)	All UXO containing pyrotechnic fillers other than white phosphorous (e.g., flares, signals, simulators, smoke grenades).	20	
	All DMM containing pyrotechnic fillers other than white phosphorous (e.g., flares, signals, simulators, smoke grenades) that have been damaged by burning or detonation, or deteriorated to the point of instability.		
High explosive (unused)	All DMM containing a high-explosive filler that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.	15	
Propellant	All UXO containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor).	15	
	All DMM containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor) that are damaged by burning or detonation, or deteriorated to the point of instability		
Bulk secondary high explosives, pyrotechnics, or propellant	All DMM containing mostly single-, double-, or triple-based propellant, or composite propellants (e.g., a rocket motor), that are deteriorated	10	
	Bulk secondary high explosives, pyrotechnic compositions, or propellant (not contained in a munition), or mixtures of these with environmental media such that the mixture poses an explosive hazard.		
Pyrotechnic (not used or damaged)	All DMM containing a pyrotechnic filler (i.e. red phosphorous), other than white phosphorous filler, that have not been damaged by burning or detonation, or are not deteriorated to the point of instability	10	
Practice	All UXO that are practice munitions that are not associated with a sensitive fuze.	5	
	All DMM that are practice munitions that are not associated with a sensitive fuze and that have not been damaged by burning or detonation, or are not deteriorated to the point of instability.		
Riot control	All UXO or DMM containing a riot control agent filler (e.g., tear gas).	3	
Small arms	All used munitions or DMM that are categorized as small arms ammunition [Physical evidence or historical evidence that no other types of munitions (e.g., grenades, subcaliber training rockets, demolition charges) were used or are present on the MRS is required for selection of this category.].	2	
Evidence of no munitions	Following investigation of the MRS, there is physical evidence that there are no UXO or DMM present, or there is historical evidence indicating that no UXO or DMM are present.	0	0
MUNITIONS TYPE	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 30).		**0**

DIRECTIONS: Document any MRS-specific data used in selecting the ***Munitions Type*** classifications in the space below.

No MEC was identified at the MRS during the RI intrusive investigation activities. MDAS items of various types, including M397 series 40mmhigh explosive (HE) grenades, M49 series 60mm mortars, M72 series 75mm projectile, M557 series fuzes, 175mm projectiles, HE anti-tank warheads, and assorted fuzes, were encountered at depths ranging from 1 inch to 4 feet bgs during the RI (RI Report, Section 4.1.3.1 and 4.1.3.2). During the FS, the project team re-evaluated the findings of the RI and determined that historical reports of MEC on the surface of the MRS (anti-personnel fragmentation bomb and demilitarized 175mm projectile) were not representative of the non-hazardous subsurface MD present (FS, Section 2.1.1.1). No explosive hazards are anticipated at the Group 8 MRS.

Table 10

Determining the EHE Module Rating

DIRECTIONS:

1. From Tables 01 - 09, record the data element scores in the **Score** boxes to the right.

2. Add the **Score** boxes for each of the three factors and record this number in the **Value** boxes to the right.

3. Add the three **Value** boxes and record this number in the **EHE Module Total** box below.

4. Identify the appropriate range for the **EHE Module Total** at right.

5. Identify the **EHE Module Rating** that corresponds to the range selected and record this rating in the **EHE Module Rating** box at the lower right corner of this table.

NOTE: An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more data elements, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.

	Source	Score	Value
Explosive Hazard Factor Data Elements			
Munitions Type	Table 01	0	0
Source of Hazard	Table 02	0	
Accessibility Factor Data Elements			
Location of Munitions	Table 03	0	0
Ease of Access	Table 04	0	
Status of Property	Table 05	0	
Receptor Factor Data Elements			
Population Density	Table 06	0	0
Population Near Hazard	Table 07	0	
Types of Activities/Structures	Table 08	0	
Ecological and/or Cultural Resources	Table 09	0	
EHE MODULE TOTAL			**0**

EHE Module Total	EHE Module Rating
92 to 100	A
82 to 91	B
71 to 81	C
60 to 70	D
48 to 59	E
38 to 47	F
less than 38	G
Alternative Module Ratings	Evaluation Pending
	No Longer Required
	No Known or Suspected Explosive Hazard
EHE MODULE RATING	**No Known or Suspected Explosive Hazard**

Table 11

CHE Module: CWM Configuration Data Element Table

Directions: Below are seven classifications of CWM configuration and their descriptions. Annotate the score(s) that correspond to **all** CWM configurations known or suspected to be present at the MRS.

Note: The terms *CWM/UXO*, *CWM/DMM*, *physical evidence*, and *historical evidence* are defined in Appendix C of the MRSPP Primer (Draft, Dec 2005).

Classification	Description	Possible Score	Score
CWM, explosive configuration either UXO or damaged DMM	The CWM known or suspected of being present at the MRS is (a) explosively configured CWM that are UXO (i.e. CWM/UXO), or (b) explosively configured CWM that are DMM (i.e. CWM/DMM) that have been damaged.	30	
CWM mixed with UXO	The CWM known or suspected of being present at the MRS are explosively configured CWM/DMM that have not been damaged, or nonexplosively configured CWM/DMM, or CWM not configured as a munition, that are commingled with conventional munitions that are UXO.	25	
CWM, explosive configuration that are undamaged DMM	The CWM known or suspected of being present at the MRS are explosively configured CWM/DMM that have not been damaged.	20	
CWM, not explosively configured or CWM, bulk container	The CWM known or suspected of being present at the MRS is (a) nonexplosively configured CWM/DMM, or (b) bulk CWM/DMM (e.g., ton container).	15	
CAIS K941 and CAIS K942	The CWM/DMM known or suspected of being present at the MRS is CAIS K941(toxic gas set M-1) or CAIS K942 (toxic gas set M-2/E11).	12	
CAIS (chemical agent identification sets)	Only CAIS, other than CAIS K941 and K942, are known or suspected of being present at the MRS.	10	
Evidence of no CWM	Following investigation, the physical evidence indicates that CWM are not present at the MRS, or the historical evidence indicates that CWM are not present at the MRS.	0	0
CWM CONFIGURATION	**DIRECTIONS:** Record **the single highest score** from above in the box to the right (maximum score = 30).		**0**

DIRECTIONS: Document any MRS-specific data used in selecting the ***CWM Configuration*** classifications in the space below.

The RVAAP is listed on the Non-Stockpile CWM List as a site with known or possible buried CWM; however, there is no known historical or physical evidence of CWM being produced, stored, or used at the MRS. As such, Tables 12-19 are not applicable and have intentionally been omitted according to active Army guidance.

Table 20

Determining the CHE Module Rating

DIRECTIONS:

1. From Tables 11 - 19, record the data element scores in the **Score** boxes to the right.

2. Add the **Score** boxes for each of the three factors and record this number in the **Value** boxes to the right.

3. Add the three **Value** boxes and record this number in the **CHE Module Total** box below.

	Source	Score	Value
CWM Hazard Factor Data Elements			
CWM Configuration	Table 11	0	0
Sources of CWM	Table 12	0	
Accessibility Factor Data Elements			
Location of CWM	Table 13	0	0
Ease of Access	Table 14	0	
Status of Property	Table 15	0	
Receptor Factor Data Elements			
Population Density	Table 16	0	0
Population Near Hazard	Table 17	0	
Types of Activities/Structures	Table 18	0	
Ecological and/or Cultural Resources	Table 19	0	
CHE MODULE TOTAL			**0**

4. Identify the appropriate range for the **CHE Module Total** at right.

5. Identify the **CHE Module Rating** that corresponds to the range selected and record this rating in the **CHE Module Rating** box at the lower right corner of this table.

NOTE: An alternative module rating may be assigned when a module letter rating is inappropriate. An alternative module rating is used when more information is needed to score one or more data elements, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.

CHE Module Total	CHE Module Rating
92 to 100	A
82 to 91	B
71 to 81	C
60 to 70	D
48 to 59	E
38 to 47	F
less than 38	G
Alternative Module Ratings	Evaluation Pending
	No Longer Required
	No Known or Suspected CWM Hazard
CHE MODULE RATING	**No Known or Suspected CWM Hazard**

Table 21

HHE Module: Groundwater Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's groundwater and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the groundwater, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
No groundwater samples collected during RI (RI Report, Section 3.0)			
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = ∑ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the groundwater migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the groundwater is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in groundwater has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the groundwater to a potential point of exposure (possibly due to geological structures or physical controls).	L
MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the groundwater receptors at the MRS.

Classification	Description	Value
Identified	There is a threatened water supply well downgradient of the source and the groundwater is a current source of drinking water or source of water for other beneficial uses such as irrigation/agriculture (equivalent to Class I or IIA aquifer).	H
Potential	There is no threatened water supply well downgradient of the source and the groundwater is currently or potentially usable for drinking water, irrigation, or agriculture (equivalent to Class I, IIA, or IIB aquifer).	M
Limited	There is no potentially threatened water supply well downgradient of the source and the groundwater is not considered a potential source of drinking water and is of limited beneficial use (equivalent to Class IIIA or IIIB aquifer, or where perched aquifer exists only).	L
RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Groundwater MC Hazard

Table 22

HHE Module: Surface Water - Human Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface water and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the surface water, select the box at the bottom of the table.

Note: Use dissolved, rather than total, metals analyses when both are available.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
No surface water collected during RI (RI Report, Section 3.0)			
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = ∑ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface water has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface water to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface water to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface water to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Surface Water (Human Endpoint) MC Hazard	

Table 23

HHE Module: Sediment - Human Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the site's sediment and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for human endpoints present in the sediment, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
No sediment samples collected during RI (RI Report, Section 3.0)			
		Total from Table 27	

CHF Scale	CHF Value	Sum the Ratios
CHF > 100	H (High)	CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])
100 > CHF >2	M (Medium)	
2 > CHF	L (Low)	

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the sediment is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in sediment has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the sediment to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to sediment to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to sediment to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to sediment to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Sediment (Human Endpoint) MC Hazard	

Table 24

HHE Module: Surface Water - Ecological Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface water and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for ecological endpoints present in the surface water, select the box at the bottom of the table.

Note: Use either dissolved or total metals analyses.

Contaminant [CAS No.]	Maximum Concentration (µg/L)	Comparison Value (µg/L)	Ratios
No surface water samples collected during RI (RI Report, Section 3.0)			
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value	
CHF > 100	H (High)	CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])
100 > CHF >2	M (Medium)	
2 > CHF	L (Low)	

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface water is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface water has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface water to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface water to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface water to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface water to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Surface Water (Ecological Endpoint) MC Hazard	

Table 25

HHE Module: Sediment - Ecological Endpoint Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's sediment and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard for ecological endpoints present in the sediment, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
No sediment samples collected during RI (RI Report, Section 3.0)			
		Total from Table 27	
		Sum the Ratios	

CHF Scale	CHF Value
CHF > 100	H (High)
100 > CHF >2	M (Medium)
2 > CHF	L (Low)

CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface water migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the sediment is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in sediment has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the sediment to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface water receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to sediment to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to sediment to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to sediment to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	

Place an "X" in the box to the right if there is no known or suspected Sediment (Ecological Endpoint) MC Hazard	

Table 26

HHE Module: Surface Soil - Data Element Table

Contaminant Hazard Factor (CHF)

Directions: Record the **maximum concentrations** of all contaminants in the MRS's surface soil and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Additional contaminants can be recorded on Table 27. Calculate and record the **ratios** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** by adding the **ratios** for each medium together, including additional contaminants recorded on Table 27. Based on the **CHF**, use the **CHF Scale** to determine and record the **CHF Value**. If there is no known or suspected MC hazard present in the surface soil, select the box at the bottom of the table.

Note: N/A

Contaminant [CAS No.]	Maximum Concentration (mg/kg)	Comparison Value (mg/kg)	Ratios
Cadmium [7440-43-9]	396.00	39.00	10
Lead [7439-92-1]	977.00	400.00	2
Benzo(a)anthracene [56-55-3]	0.41	62.00	0
Benzo(a)pyrene [50-32-8]	0.27	6.20	0
		Total from Table 27	1
		Sum the Ratios	13

CHF Scale	CHF Value
CHF > 100	**H (High)**
100 > CHF >2	**M (Medium)**
2 > CHF	**L (Low)**

CHF = $\sum$ ([Max Conc of Contaminant] / [Comparison Value for Contaminant])

CONTAMINANT HAZARD FACTOR	Directions: Record **the CHF Value** from above in the box to the right (maximum value = H).	**M**

Migratory Pathway Factor

Directions: Annotate the value that corresponds most closely to the surface soil migratory pathway at the MRS.

Classification	Description	Value
Evident	Analytical data or observable evidence indicates that contamination in the surface soil is present at, moving toward, or has moved to a point of exposure.	H
Potential	Contamination in surface soil has moved only slightly beyond the source (i.e. tens of feet), could move but is not moving appreciably, or information is not sufficient to make a determination of Evident or Confined.	M
Confined	Information indicates a low potential for contaminant migration from the source via the surface soil to a potential point of exposure (possibly due to presence of geological structures or physical controls).	L

MIGRATORY PATHWAY FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	**M**

Receptor Factor

Directions: Annotate the value that corresponds most closely to the surface soil receptors at the MRS.

Classification	Description	Value
Identified	Identified receptors have access to surface soil to which contamination has moved or can move.	H
Potential	Potential for receptors to have access to surface soil to which contamination has moved or can move.	M
Limited	Little or no potential for receptors to have access to surface soil to which contamination has moved or can move.	L

RECEPTOR FACTOR	Directions: Record **the single highest value** from above in the box to the right (maximum value = H).	**M**
	Place an "X" in the box to the right if there is no known or suspected Surface Soil MC Hazard	**X**

Table 27

HHE Module: Supplemental Contaminant Hazard Factor Table

Contaminant Hazard Factor (CHF)

Directions: **Only use this table if there are more than five contaminants present at the MRS.** This is a supplemental table designed to hold information about contaminants that do not fit in the previous tables. Indicate the **media** in which these contaminants are present. Then record all **contaminants**, their **maximum concentrations** and their **comparison values** (from Appendix B, Relative Risk Site Evaluation (RRSE) Primer, Summer 1997 - Revised) in the table below. Calculate and record the **ratio** for each contaminant by dividing the **maximum concentration** by the **comparison value**. Determine the **CHF** for each medium on the appropriate media-specific tables.

Note: For human exposures to groundwater and surface water, use dissolved, rather than total, metals analyses when both are available. Remember not to add ratios from different media.

Media	Contaminant [CAS No.]	Maximum Concentration	Units	Comparison Value	Units	Ratios
Surface soil	Benzo(b)fluoranthene [205-99-2]	0.46	mg/kg	62.00	mg/kg	0
Surface soil	Dibenzo(a,h)anthracene [53-70-3]	0.06	mg/kg	6.20	mg/kg	0
Surface soil	Acrolor-1254 [11097-69-1]	0.74	mg/kg	1.10	mg/kg	1
Surface soil	Acrolor-1260 [11096-82-5]	0.41	mg/kg	22.00	mg/kg	0
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
Surface soil			mg/kg		mg/kg	
				SUBTOTAL FOR SURFACE SOIL		**1**
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
Sediment			mg/kg		mg/kg	
				SUBTOTAL FOR SEDIMENT		**0**
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
Surface water			µg/L		µg/L	
				SUBTOTAL FOR SURFACE WATER		**0**
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
Groundwater			µg/L		µg/L	
				SUBTOTAL FOR GROUNDWATER		**0**

Table 28

Determining the HHE Module Rating

DIRECTIONS:

1. Record the letter values (H, M, L) for the **Contaminant Hazard**, **Migration Pathway**, and **Receptor Factors** for the media (from Tables 21 - 26) in the corresponding boxes below.
2. Record the media's three-letter combinations in the **Three-Letter-Combination** boxes below (three-letter combinations are arranged from Hs to Ms to Ls).
3. Using the reference provided below, determine each medium's rating (A - G) and record the letter in the corresponding **Media Rating** box below.

Medium (Source)	Contaminant Hazard Factor Value	Migratory Pathway Factor Value	Receptor Factor Value	Three-Letter Combination (Hs-Ms-Ls)	Media Rating (A - G)
Table 21 - Groundwater					
Table 22 - Surface Water (Human Endpoint)					
Table 23 - Sediment (Human Endpoint)					
Table 24 - Surface Water (Ecological Endpoint)					
Table 25 - Sediment (Ecological Endpoint)					
Table 26 - Surface Soil	M	M	M	MMM	D
			HHE MODULE RATING		**D**

DIRECTIONS (Continued):

4. Select the single highest **Media Rating** (A is the highest; G is the lowest) and enter the letter in the **HHE Module Rating** box below.

HHE Ratings (for reference only)	
HHH	A
HHM	B
HHL	C
HMM	C
HML	**D**
MMM	**D**
HLL	E
MML	E
MLL	F
LLL	G

NOTE: An alternative module rating may be assigned when a module letter rating is used when more information is needed to score one or more media, contamination at an MRS was previously addressed, or there is no reason to suspect contamination was ever present at an MRS.

Alternative Module Ratings
Evaluation Pending
No Longer Required
No Known or Suspected MC Hazard

Table 29

MRS Priority

DIRECTIONS: In the chart below, enter the letter **rating** for each module recorded in Table 10 (EHE), Table 20 (CHE), and Table 28 (HHE). Enter the corresponding numerical **priority** for each module. If information to determine the module rating is not available, choose the appropriate alternative module rating. The MRS priority is the single highest priority; record this number in the **MRS or Alternative Priority** box at the bottom of the table.

NOTE: An MRS assigned Priority 1 has the highest relative priority; an MRS assigned Priority 8 has the lowest relative priority. Only an MRS with CWM known or suspected to be present can be assigned Priority 1; an MRS that has CWM known or suspected to be present cannot be assigned Priority 8.

EHE Rating	Priority	CHE Rating	Priority	HHE Rating	Priority
		A	1		
A	2	B	2	A	2
B	3	C	3	B	3
C	4	D	4	C	4
D	5	E	5	D	5
E	6	F	6	E	6
F	7	G	7	F	7
G	8			G	8
Evaluation Pending		Evaluation Pending		Evaluation Pending	
No Longer Required		No Longer Required		No Longer Required	
No Known or Suspected Explosive Hazard		**No Known or Suspected CWM Hazard**		No Known or Suspected MC Hazard	

Reference Table 10:		Reference Table 20:		Reference Table 28:	
EHE Module Rating	**Priority**	**CHE Module Rating**	**Priority**	**HHE Module Rating**	**Priority**
No Known or Suspected Explosive Hazard	**No Known or Suspected Explosive Hazard**	**No Known or Suspected CWM Hazard**	**No Known or Suspected CWM Hazard**	**D**	**5**

MRS or Alternative Priority	**5**