Final
Feasibility Study for
RVAAP-060-R-01 Block D Igloo Munitions Response Site
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
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April 23, 2018

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This Final Feasibility Study for RVAAP-060-R-01 Block D Igloo Munitions Response Site (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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Mary Taylor, Lt. Governor
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June 6, 2018

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Arlington, VA 22204

Re: US Army Ravenna Ammunition Plt RVAAP
Remediation Response
Project records
Remedial Response
Portage County
267000859196

Subject: Review of the "Final Feasibility Study for RVAAP-060-R-01 Block D Igloo Munitions Response Site, Version 1.0" at the Former Ravenna Army Ammunition Plant; Ravenna, Ohio: Dated April 23, 2018 (Work Activity No. 267000859196)

Dear LTC Crowley:

The Ohio Environmental Protection Agency (Ohio EPA), Northeast District Office (NEDO), Division of Environmental Response and Revitalization (DERR) has received and reviewed the document entitled, "Final Feasibility Study for RVAAP-060-R-01 Block D Igloo Munitions Response Site, Version 1.0," dated April 23, 2018. This document, received by Ohio EPA, NEDO on April 24, 2018, was prepared for the U.S. Army Corps of Engineers (USACE) Baltimore District, by HydroGeoLogic, Inc. Ohio EPA has no comments and accepts the final feasibility study in its final format.

If you have any questions or concerns, please do not hesitate to contact me at (330) 963-1235.

Sincerely,

Nicholas Roope
Site Coordinator
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08 JUN 2018

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CONTRACTOR'S STATEMENT OF INDEPENDENT TECHNICAL REVIEW

HydroGeoLogic, Inc. has completed this *Final Feasibility Study for RVAAP-060-R-01 Block D Igloo Munitions Response Site, Former Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio, Version 1.0*. 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.

Prepared/Approved by: Janardan J Patel Digitally signed by Janardan J Patel DN: cn=Janardan J Patel, o=HGL, ou=ECD, email=jpatel@hgl.com, c=US Date: 2018.04.23 14:24:06 -04'00' Date: April 23, 2018

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Prepared/Approved by: Kimberly Vaughn Date: April 23, 2018

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Project Manager

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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 Ammunitions Plant
USACE – United States Army Corps of Engineers

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Acronyms and Abbreviations

AC	Advanced Classification
AEDB-R	Army Environmental Database - Restoration Module
AOC	Area of Concern
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
bgs	below ground surface
BIP	blow-in-place
Camp Ravenna	Camp Ravenna Joint Military Training Center
CB&I	CB&I Federal Services LLC
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	Code of Federal Regulations
CSM	conceptual site model
CWA	*Clean Water Act of 1977*
DERP	Defense Environmental Restoration Program
DGM	digital geophysical mapping
DoD	U.S. Department of Defense
EM	electromagnetic
EOD	explosive ordnance disposal
EPA	U.S. Environmental Protection Agency
ER	Engineering Regulation
ESA	*Endangered Species Act*
FS	Feasibility Study
GRA	general response action
HFD	hazardous fragment distance
IA	*Final Facility-Wide Institutional Analysis for the Former Ravenna Army Ammunition Plant*
lb	pound
INRMP	*Integrated Natural Resources Management Plan and Environmental Assessment for the Ravenna Training and Logistics Site*
LUC	land-use control
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MDEH	material documented as an explosive hazard
MEC	munitions and explosives of concern
MEC HA	*Munitions and Explosives of Concern Hazard Assessment*
MFD	maximum fragment distance
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MRS	Munitions Response Site
NCP	*National Oil and Hazardous Substances Pollution Contingency Plan*
O&M	operation and maintenance
OAC	Ohio Administrative Code
OHARNG	Ohio Army National Guard
Ohio EPA	Ohio Environmental Protection Agency
RAO	remedial action objective

Acronyms and Abbreviations (continued)

RI	Remedial Investigation
ROD	Record of Decision
RVAAP	former Ravenna Army Ammunition Plant
TBC	to be considered
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USP&FO	U.S. Property and Fiscal Officer
UU/UE	unlimited use/unrestricted exposure
UXO	unexploded ordnance

EXECUTIVE SUMMARY

Introduction

HydroGeoLogic, Inc. 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 Block D Igloo Munitions Response Site (MRS) at the former Ravenna Army Ammunition Plant (RVAAP). The former RVAAP, now known as the Camp Ravenna Joint Military Training Center (Camp Ravenna), is located in Portage and Trumbull Counties, Ohio. This FS is being prepared under Delivery Order No. 0001 under the *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 explosive hazards at the MRS that are protective of human and environmental 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 munitions and explosives of concern (MEC) at the Block D Igloo MRS.

Block D Igloo MRS History and Background

The "D" Block storage bunkers (igloos) are located in the north-central portion of Camp Ravenna within Portage County. On March 24, 1943, 2,516 clusters of M-41 20-pound (lb) fragmentation bombs exploded in Igloo 7-D-15 during loading into the bunker for storage. The explosion was reported to have been caused by rough handling and the faulty design of the M-110 fuze. At the time of the incident, Igloo 7-D-15 was 95 percent full.

The 60-foot-long igloo was constructed of reinforced concrete with a steel door. The bunker was primarily earthen covered with the exception of the front of it where the door was located. The igloo-shaped configuration of the bunker was designed to protect the personnel at the former RVAAP and the nearby residential communities from external force in the event of an internal explosion. The directional configuration of Igloo 7-D-15 and the door location was toward the east.

The Block D Igloo MRS is 101.6 acres and extends from the location of former Igloo 7-D-15 to the east toward the "E" Block igloos, a distance of nearly 2,500 feet. The distance was derived from a boundary evaluation that was conducted for the Remedial Investigation (RI) and conservatively represents the furthest distance (2,389 feet) that an M-41 20-lb fragmentation bomb, intact or in pieces, could have traveled as a result of the 1943 explosion. The MRS boundary includes a 100-foot buffer zone beyond that distance as well as from the bound lateral extent of material potentially presenting an explosive hazard (MPPEH) that was verified as material documented as safe (MDAS) (i.e., munitions debris [MD]) during the RI (CB&I Federal Services LLC [CB&I], 2015).

The MRS is mostly heavily wooded with thick vegetation and ground cover. Roads, fields, and wetlands are also located within the boundaries of the MRS. A small, unnamed stream originates near the center of the MRS and flows east toward Sand Creek. Approximately 0.8 acres of a larger wetland area is located along the eastern edge of the MRS. A small, 0.25-acre jurisdictional wetland is present at the central portion of the MRS (CB&I, 2015). The wetlands at the MRS are either forested wetlands or wet fields (Ohio Army National Guard [OHARNG], 2014).

The current land use activities at the MRS are maintenance, natural resource management, environmental sampling, and military training. The future land use will not change. The human receptor that has the greatest opportunity for exposure to an explosive hazard 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 military personnel who are expected to work daily at Camp Ravenna over their career (Army National Guard, 2014).

A total of 178 MPPEH were found on the ground surface during the RI and were documented as MDAS (i.e., MD) by the unexploded ordnance (UXO)-qualified personnel in the field. A total of 3,140 subsurface MPPEH were encountered during the RI at a maximum depth of 8 inches below ground surface (bgs). The UXO-qualified personnel determined that 3,135 of the MPPEH were MD and 5 of the MPPEH were MEC. The MEC items were in corroded condition and weighed between 1 to 5 lbs. The MEC items were firmly entrenched in the ground at a maximum depth of 0.5 feet (6 inches) bgs and required hand tools (i.e., shovels) in order to be removed. The MD and MEC found consisted of bomb fragmentation sleeves and tail fin assemblies associated with the M-41 20 lb fragmentation bomb that exploded in 1943, with the exception of one MEC item that was a fuze from an unknown munitions type. The maximum distance of the MD found on the ground surface was approximately 1,800 feet due east. Sampling for munitions constituents (MC) was conducted during the RI at areas with concentrated MPPEH and beneath individual MEC. The sample results indicate there are no MC risks at the MRS (CB&I, 2015).

Problem Identification

MEC was found during the RI field work, and the presence of an explosive hazard at the MRS is confirmed. Based on the results of the RI and the history of the MRS as the location where the accidental detonation of 2,516 clusters of M-41 20-lb fragmentation bombs occurred, the probability exists for residual MEC to be present on the surface and in the subsurface as well as in sediment in the saturated and surface water areas at the MRS. The presence of the MEC represents a potential explosive risk to the Industrial Receptor that has a maximum exposure depth of 4 feet bgs in subsurface soils and may access the surface water and saturated areas at the MRS.

Remedial Action Objectives

The remedial action objectives (RAOs) are developed to determine the effectiveness of the remedial action based on the conceptual site model for the MRS and are focused on limiting or removing exposure pathways for MEC (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 managing the potential residual explosive hazards and protecting human receptors from these hazards. This FS addresses the potential for explosive hazards from residual MEC remaining at the Block D Igloo MRS. Primary media of concern at the MRS are surface and subsurface soil between ground surface to 4 feet bgs, the maximum exposure depth for the Industrial Receptor. The maximum depth of MEC that was found during the RI was less than 1 foot bgs which is less than the maximum exposure depth. The Industrial Receptor is considered the representative receptor for the current and future land uses including receptors that may access the sediment at the saturated and surface water areas at the MRS. The saturated and surface water areas at the MRS are relatively shallow (i.e., less than 3 feet) and seasonal fluctuations in water levels may result in the potential for Industrial Receptor to be able to come into contact with MEC on the sediment surface by walking or handling if picked up. Based on the Industrial Receptor exposure scenario in relation to the maximum depth recoveries for MEC during the RI, the following RAOs were developed for the Block D Igloo MRS:

Reduce the unacceptable potential hazard of MEC on the ground surface and in sediment at the saturated and surface water areas within the MRS to address the likelihood of exposure to the Industrial Receptor via direct contact such that the likelihood of encounter is negligible.

Reduce the unacceptable potential hazard of MEC to a depth of 4 feet bgs within the MRS to address the likelihood of exposure to the Industrial Receptor via direct contact such that the likelihood of encounter is negligible.

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 Block D Igloo 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 MEC hazards. 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§300) requires that a "No Action" alternative be evaluated to provide a baseline for comparison to other alternatives. This alternative would provide no action to protect potential human receptors at the MRS.

Alternative 2, Land-Use Controls (LUCs)—Under this alternative, no planned removal of MEC would be taken to reduce any potential hazards to human receptors. There would be no measured reduction in toxicity or volume through treatment of MEC at the MRS with the exception of the removal of incidental MEC during installation of engineering controls or removal of MEC that may be found in the future. LUCs consisting of engineering and educational controls would be implemented and would focus on reducing potential human exposure to MEC by managing and monitoring the activities occurring at the MRS.

Alternative 3, Surface Removal and LUCs—This alternative includes the systematic search and removal of all MEC on or just below the ground surface and the sediment in the saturated and surface water areas at the MRS using hand-held analog instruments. Implementation of this alternative would not attain unlimited use/unrestricted exposure (UU/UE) since subsurface MEC would remain. LUCs consisting of engineering and educational controls would be required to be implemented to control behaviors and protect receptors from residual MEC in the subsurface.

Alternative 4, Surface and Subsurface Removal (UU/UE)—This alternative conservatively includes the systematic search and removal of all MEC in the surface, subsurface, and sediment utilizing full-coverage of the MRS with analog and digital magnetometer instruments and manual excavation of target anomalies. Successful completion of this alternative would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor at the MRS.

Once the remedial alternatives were assembled, they were described and preliminarily screened against the three criteria of effectiveness, implementability, and cost. Alterative 1 was retained for baseline evaluation in accordance with the CERCLA requirements. Evaluations of Alternatives 2 through 4 indicated that they met the three criteria and were retained for further detailed analysis.

A detailed analysis was completed for each retained alternative using the nine evaluation criteria defined by the NCP as well as information included in the updated *Munitions and Explosives of Concern Hazard Assessment* (MEC HA) that was prepared for the MRS. The MEC HA provides an assessment of relative hazard reduction associated with the remedial alternatives presented in this FS. 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 the history of the MRS as the location where the accidental detonation of 2,516 clusters of M-41 20 lb fragmentation bombs occurred, the potential remains for residual MEC to be present in the surface and subsurface soil and sediment at the MRS. The potential presence of MEC on the MRS presents a potential explosive hazard to the Industrial Receptor via direct contact to a maximum exposure depth of 4 feet bgs. The NCP statutory preference for reduction of toxicity, mobility, or volume through treatment is best achieved with Alternative 4 that would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor. Based on the evaluation of the NCP criteria, Alternative 2 (LUCs), Alternative 3 (Surface Removal and LUCs), and Alternative 4 (Surface and Subsurface Removal) are acceptable to implement. The deciding factor in selecting a remedy will be the lowest-cost alternative that meets the RAOs and is technically and administratively implementable.

The MEC HA categorizes Alternative 1 as a “moderate potential explosive hazard condition” (i.e., Hazard Level 3). The Hazard Level would not change for Alternative 2, since no planned removal of MEC would occur; however, Alternative 2 takes action to mitigate potentially remaining MEC risks at the MRS through engineering and educational controls to restrict direct contact of the Industrial Receptor with the MEC. Alternatives 3 and 4 involve the physical removal of MEC to differing degrees, which both result in a “low potential explosive hazard condition” (i.e., Hazard Level 4). Although Alternatives 3 and 4 have the same Hazard Level, the MEC HA score is lower for Alternative 4 (355) than for Alternative 3 (390). The lower score for Alternative 4 indicates there is less of an explosive hazard condition due to a more robust removal action that involves both surface and subsurface MEC; whereas, only surface removal is performed under Alternative 3.

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 and the MEC HA Hazard Level outputs.

Table ES-1. Comparison of Alternatives

CERCLA Evaluation Criteria	Remedial Alternatives			
	Alternative 1 No Action	Alternative 2 LUCs	Alternative 3 Surface Removal and LUCs	Alternative 4 Surface and Subsurface Removal (UU/UE)
Protective of Human Health and Environment	No	Yes	Yes	Yes
Complies with Applicable or Relevant and Appropriate Requirements	Yes	Yes	Yes	Yes
Effective and Permanent	No	Medium	High	Highest
Reduces Toxicity, Mobility, or Volume through Treatment	None (no treatment)	Minimal (Incidental treatment)	Removal of Surface MEC only	Removal of MEC to achieve UU/UE
Short-Term Effectiveness	Low	Medium	High	Highest
Implementable				
Technically Feasible	Yes	Yes	Yes	Yes
Administratively Feasible	No	Yes	Yes	Yes
Costs				
Capital	$0	$626,025	$1,642,116	$7,039,235
O&M (discounted)	$0	$245,094	$245,094	$0
Periodic (discounted)	$0	$27,224	$27,224	$0
Present Worth (Capital + discounted O&M + discounted Periodic Costs)	$0	$898,343	$1,914,434	$7,039,235
Five-Year Reviews (discounted)	$0	$94,505	$94,505	$0
State Acceptance	To be determined			
Community Acceptance	To be determined			
[1]MEC HA Hazard Level Determination	Hazard Level: 3 Score: 640	Hazard Level: 3 Score: 540	Hazard Level: 4 Score: 390	Hazard Level: 4 Score 355

[1] denotes the MEC HA is not a CERCLA Evaluation Criteria but is included to supplement the evaluation of alternatives presented in this Feasibility Study.
CERCLA denotes Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
LUC denotes land-use control.
MEC denotes munitions and explosives of concern.
MEC HA denotes Munitions and Explosives of Concern Hazard Assessment.
UU/UE denotes unlimited use/unrestricted exposure.

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1.0 INTRODUCTION

HydroGeoLogic, Inc. 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 RVAAP-060-R-01 Block D Igloo 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 under the *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: Defense Environmental Restoration Program (DERP) Management* (DERP Manual; DoD, 2012), the 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]§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.

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 Remedial Investigation (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 the Camp Ravenna Joint Military Training Center (Camp Ravenna), 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 (Figure 1-1). In addition, the facility is surrounded by the communities of Windham, Garrettsville, Newton Falls, Charlestown, and Wayland.

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, Camp Ravenna. The OHARNG/Camp Ravenna oversees 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 Block D Igloo MRS is a 101.6-acre area at the north-central portion of Camp Ravenna (Figure 1-2). The MRS is between the intersection of Smalley Road and Road 7D in the "D" Block storage bunkers (igloos) and Road 3E in the "E" Block igloos. The MRS is on federal property with administrative accountability assigned to the USP&FO for Ohio. The MRS is managed by the Army National Guard (ARNG) and the OHARNG. Table 1-1 summarizes the administrative description of the MRS.

Table 1-1. Administrative Description Summary of the Block D Igloo MRS

Investigation Area	AEDB-R MRS Number	Area (Acres)	Property Owner	MRS Management Responsibility
Block D Igloo MRS	RVAAP-060-R-01	101.6	USP&FO	ARNG/OHARNG

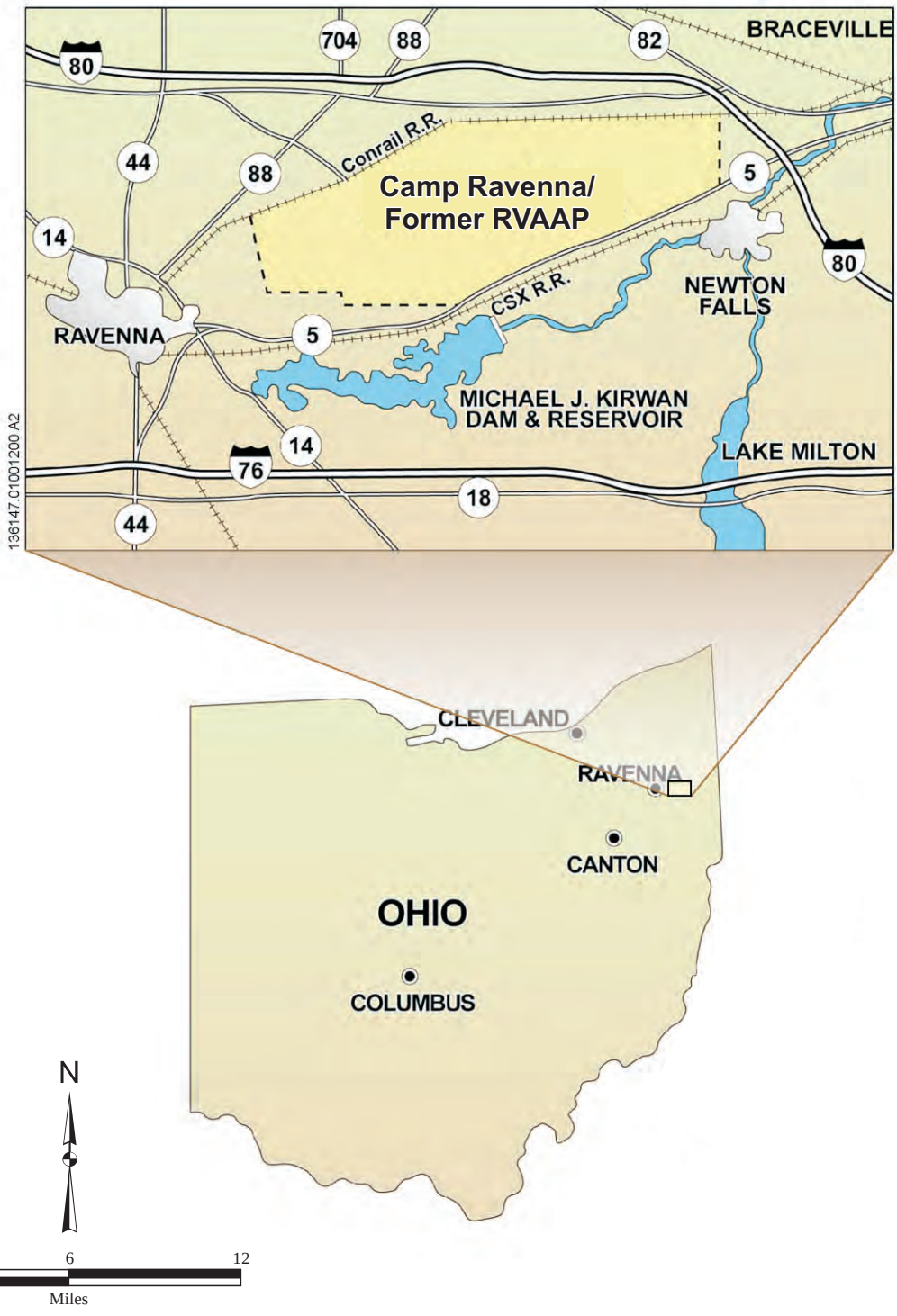
ARNG denotes Army National Guard.
AEDB-R denotes Army Environmental Database - Restoration Module.
MRS denotes Munitions Response Site.
OHARNG denotes Ohio Army National Guard.
USP&FO denotes U.S. Property and Fiscal Officer.

The *Facility-Wide Institutional Analysis for the Former Ravenna Army Ammunition Plant*; hereafter, referred to as the (IA) is presented in Appendix A and identifies land use control (LUC) technologies, identifies those entities having jurisdiction over Camp Ravenna; and assesses the appropriateness, capability, and willingness of government agencies to implement and maintain LUCs at Camp Ravenna. The institutional analysis determined that the ARNG has financial capability to implement LUCs at Camp Ravenna and coordinates the implementation with the OHARNG. The OHARNG/Camp Ravenna is willing to implement, maintain, and enforce LUCs at this MRS.

1.4 MRS Description

On March 24, 1943, 2,516 clusters of M-41 20-pound (lb) fragmentation bombs exploded in Igloo 7-D-15 as they were being loaded into the bunker for storage. The explosion was reportedly caused by rough handling and faulty design of the M-110 fuze. At the time of the incident, Igloo 7-D-15 was 95 percent full.

The 60-foot-long igloo was constructed of reinforced concrete with a steel door. The bunker was primarily earthen covered with the exception of the front of it where the door was located. The igloo-shaped configuration of the bunker was designed to protect the personnel at the former RVAAP and the nearby residential communities from external force in the event of an internal explosion. The directional configuration of Igloo 7-D-15 and the door location was toward the east.



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Camp Ravenna/Former RVAAP

Figure 1-1
Location Map
Camp Ravenna/
Former RVAAP
Portage and Trumbull Counties, Ohio

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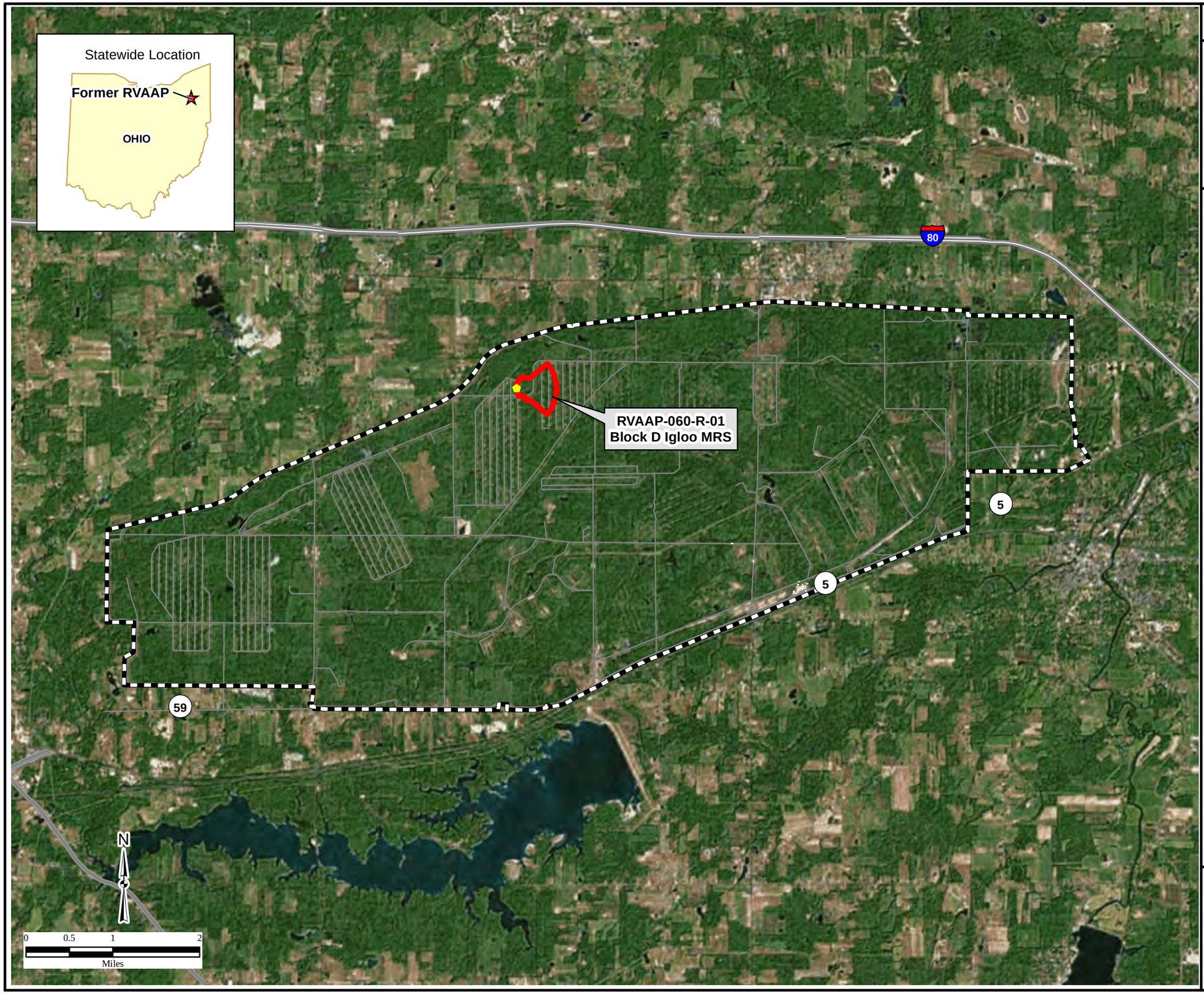

HGL—Feasibility Study—Former RVAAP, Ohio

Figure 1-2
MRS Location
Camp Ravenna/Former RVAAP
Portage/Trumbull Counties, Ohio

Legend

- Igloo 7-D-15
- RVAAP-060-R-01 Block D Igloo MRS Boundary
- Facility Boundary
- Road

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

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The Block D Igloo MRS is 101.6 acres and extends from the location of former Igloo 7-D-15 to the east toward the "E" Block igloos, a distance of nearly 2,500 feet. The distance was derived from a boundary evaluation that was conducted for the RI and conservatively represents the furthest distance (2,389 feet) that an M-41 20 lb fragmentation bomb, intact or in pieces, could have traveled as a result of the 1943 explosion. The MRS boundary includes a 100-foot buffer zone beyond that distance as well as from the bound lateral extent of material potentially presenting an explosive hazards (MPPEH) that was verified as munitions documented as safe (MDAS) (i.e., munitions debris [MD]) during the RI (CB&I Federal Services LLC [CB&I], 2015). The Block D Igloo MRS is presented in Figure 1-3.

The MRS is mostly heavily wooded with thick vegetation and ground cover. Roads, fields, and wetlands are also located within the boundaries of the MRS. A small, unnamed stream originates near the center of the MRS and flows east toward Sand Creek. Approximately 0.8 acres of a larger wetland area is located along the eastern edge of the MRS. A small, 0.25-acre jurisdictional wetland is present at the central portion of the MRS (CB&I, 2015). The wetlands at the MRS are forested wetlands or wet fields (OHARNG, 2014).

1.5 Current and Projected Land Uses

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. These three land uses and representative receptors are as follows:

1) Unrestricted (Residential) Land Use—Resident Receptor (Adult and Child)
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-019-R-01 Landfill North of Winklepeck MRS and RVAAP-060-R-01 Block D Igloo MRS* (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, environmental sampling, and military training. The future land use will not change. The representative receptors identified in the Final RI Report (CB&I, 2015) for the current and future land uses at the MRS were the National Guard Trainee and the Range Maintenance Soldier. Since there is a probability of residual MEC at the MRS, Unrestricted (Residential Land Use) was not achieved during the RI. Therefore, the Industrial Receptor that represents full-time occupational personnel that may work freely on the MRS is included in this FS to evaluate the various remedial alternatives identified (ARNG, 2014). The Industrial Receptor is representative of the receptors identified in the Final RI Report (CB&I, 2015) for the current and future land use at the MRS.

The primary media of concern for the Industrial Receptor is surface and subsurface soils to a maximum exposure depth of 4 feet below ground surface (bgs). The exposure depth is determined based on the surface

soil exposure scenarios for military personnel at Camp Ravenna (i.e., the National Guard Trainee and the Range Maintenance Solider) (Science Applications International Corporation, 2010). The Industrial Receptor is also representative of receptors that may also access the wetlands within the MRS as part of current or future land use activities. Evaluation of the Industrial Receptor in this FS is presented in further detail in Section 2.0.

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 the Block D Igloo 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 during the screening process 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. The outputs from *Munitions and Explosives of Concern Hazard Assessment* (MEC HA) in Appendix B are incorporated into this section to supplement the evaluation of the individual alternatives.

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 in Section 5.0.

Section 7.0, References—This section provides a list of references for pertinent documents cited in this FS.

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Source CB&I

Legend

- Location of Former Igloo 7-D-15
- Stream
- Munitions Response Site Boundary
- Jurisdictional Wetland
- Planning Level Survey Wetlands

Figure 1-3
MRS MAP
Block D Igloo MRS
Camp Ravenna/Former RVAAP
Portage/Trumbull Counties, Ohio

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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 Block D Igloo 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.

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 CSM 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. The CSM has three sections: Sources, Interaction, and Receptors for MEC, with the exposure pathways identified for each receptor. Each section is discussed below:

Sources—Sources are those areas where MEC have entered (or may enter) the physical system. A MEC source is the location where MEC is situated or is expected to be found.

Interactions—Hazards from MEC arise from direct contact as a result of some human activity. 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 uses, as receptors are determined on that basis.

The RI field work was completed at the Block D Igloo MRS in 2012 and determined the nature and extent of MEC and MC and subsequently determined the hazards and potential risks posed to the likely receptors identified at that time. The presence of MEC was confirmed and it was recommended in the Final RI Report (CB&I, 2015) that the MRS proceed to a FS as the next course of action under the MMRP. As discussed in Section 1.5, some of the factors associated with the CSM findings in the RI, in particular the representative receptor for the current and future land use have changed since the completion of the RI. The information collected during the RI and the changes following the completion of the RI that are used to update the CSM for the Block D Igloo MRS are presented in Table 2-1.

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 that 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	101.6 acres consisting of mostly heavily wooded terrain with several roads and fields that are located within the MRS boundary. The east portion of the MRS extends into the "E" Block igloos approximately 2,500 feet from former Igloo-7-D-15 where the 1943 explosion occurred.
Structures	Existing igloos associated with the "D" Block and "E" Block Igloo areas that are no longer used for munitions storage.
Utilities	No active utilities are located within the MRS.
Security	Access to Camp Ravenna is controlled; however, once on Camp Ravenna, access to the MRS is unrestricted.
Land Use and Receptors	
Current Land Use	Maintenance, natural resource management, environmental sampling, and military training
Potential Future Land Use	Will remain the same as current land use.
Human Receptor(s)	Industrial Receptor
Wetlands, Waterways, and Sensitive Areas	• A small, unnamed stream that originates near the center of the MRS and flows east toward Sand Creek. • 0.8 acres of a planning level wetland area along the eastern edge of the MRS. • 0.25-acre jurisdictional wetlands at the central portion of the MRS. • The wetlands present within the MRS are either forested wetlands or wet fields.
Cultural Resources	A cultural resource survey was conducted of the area between the "D" and "E" Block Igloos and no eligible sites were identified.
MEC/MC Exposure	
MEC Exposure	5 MEC in subsurface soils at a maximum depth of 6 inches bgs.
MC Exposure	No unacceptable risks to any receptor including the Unrestricted (Residential) Receptor

bgs denotes below ground surface
CSM denotes conceptual site model
MC denotes munitions constituents
MEC denotes munitions and explosives of concern
MRS denotes Munitions Response Site

2.1.1.1 Source

The RI identified the source of MEC at the Block D Igloo MRS as the M-41 20-lb fragmentation bombs associated with the 1943 explosion at former Igloo 7-D-15. A total of 178 MPPEH were found on the ground surface during the RI. All of the MPPEH on the ground surface was documented as MDAS (i.e., MD) by the unexploded ordnance (UXO)-qualified personnel in the field. A total of 3,140 subsurface MPPEH were encountered during the RI at a maximum depth of 8 inches bgs. UXO-qualified personnel determined that 3,135 of the MPPEH were MD and 5 of the MPPEH were MEC. The MEC items were in corroded condition and weighed between 1 to 5 lbs. The MEC items were firmly entrenched in the ground at a maximum depth of 0.5 feet (6 inches) bgs and required hand tools (i.e., shovels) in order to be removed (CB&I, 2015).

Approximately 1 acre of saturated and surface water areas consisting of wetlands and an unnamed stream are located within the MRS. No MPPEH or MEC was found during the evaluation of the accessible portions

of the wetlands and stream during the RI; however, the presence of buried MEC at the MRS suggests that MEC may be present in the saturated and surface water areas as well.

Based on the five MEC items found during the RI, the average density is calculated to be 3.723 MEC per acre and actual density at a 95-percent confidence level is calculated to be 6.512 MEC per acre. Therefore, it is statistically possible that between 350 and 600 MEC may be present at the MRS (CB&I, 2015). Figure 2-1 presents locations of the buried MEC and the distribution of MD on the ground surface that was found during the RI field work.

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 at the Block D Igloo MRS is not expected to change from the current land use activities that consist of maintenance, natural resource management, environmental sampling, and military training. Potential users associated with current and future activities at the MRS include facility personnel, contractors, trainees, and occasional trespassers. The National Guard Trainee and the Range Maintenance Soldier were identified as the representative receptors for the current and future land uses at the MRS in the Final RI Report (CB&I, 2015); however, in accordance with the Technical Memorandum (ARNG, 2014), the human receptor that has the greatest opportunity for exposure to an explosive hazard 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 military personnel who are expected to work daily at Camp Ravenna over their career. The maximum exposure depth for the Industrial Receptor is 4 feet bgs that is below the maximum depth that MEC was found during the RI field work (6 inches bgs). The Industrial Receptor is also representative of the receptors may also access the wetlands at the MRS where the media of concern includes surface water and sediment.

Ecological receptors were identified for the MRS in the Final RI Report (CB&I, 2015) and included terrestrial invertebrates (earthworms), voles, shrews, robins, foxes, and hawks. In accordance with current guidance, humans are typically considered as the primary and often the only receptor to MEC; therefore, no ecological receptors are identified for the MRS (USACE, 2016). The presence of ecological or cultural resources on the MRS is identified; however, to avoid or mitigate response actions (e.g., vegetation removal) that could adversely affect such resources.

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 former Igloo 7-D-15 is in a mostly heavily forested area at the northern portion of the facility, and the area sits mostly as idle. Current activities at the Block D Igloo MRS include maintenance, natural resource management, environmental sampling, and military training which primarily involve foot traffic only. The future land use will not change.

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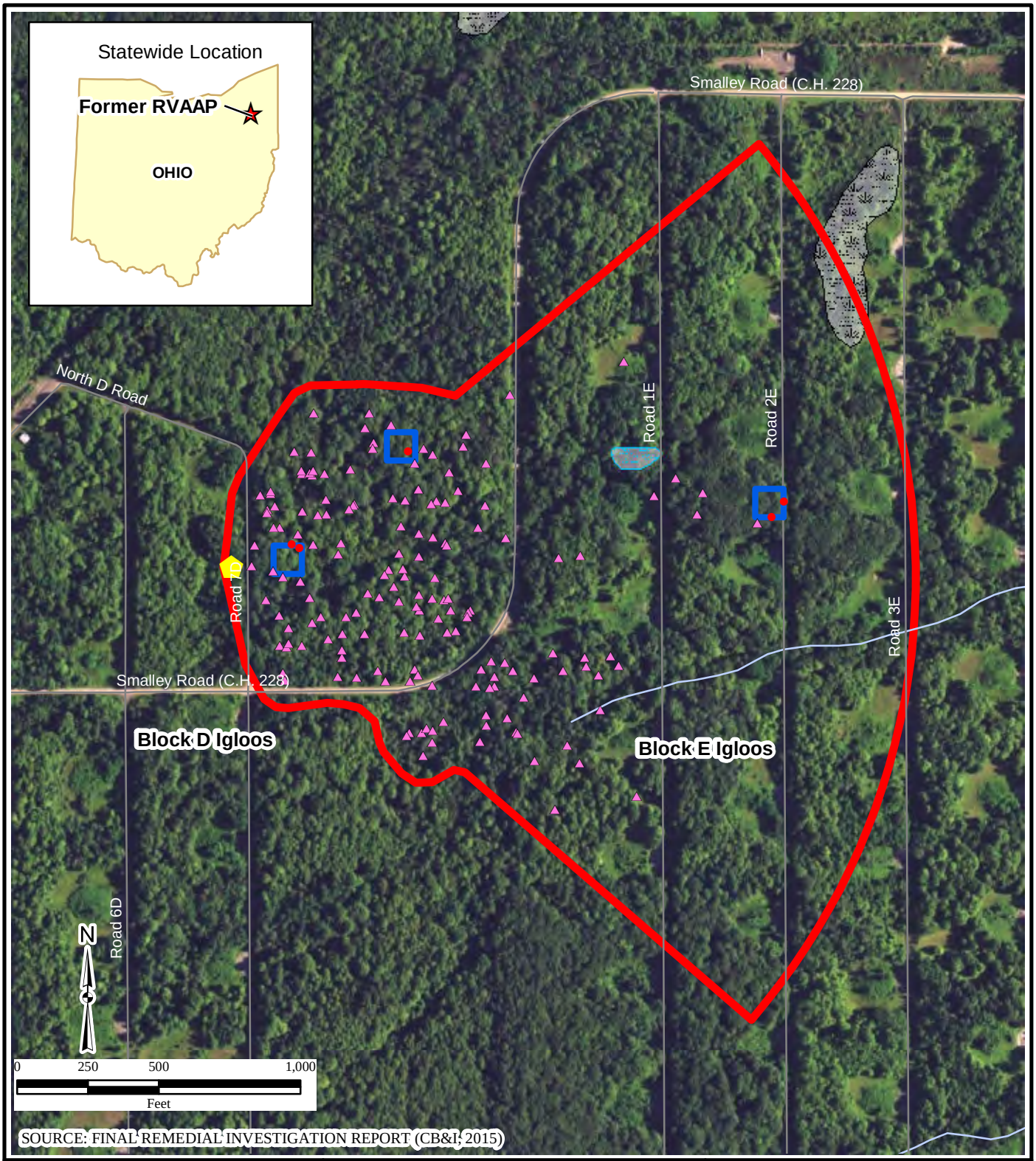

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07/13/2017 JWR
Source CB&I

Legend

- Location of Former Igloo 7-D-15
- Surface Munitions Debris (MD)
- Subsurface Munitions and Explosives of Concern (MEC)
- Remedial Investigation Dig Grid
- Stream
- Munitions Response Site Boundary
- Jurisdictional Wetland
- Planning Level Survey Wetlands

Figure 2-1
MEC and MD Locations
Block D Igloo MRS
Camp Ravenna/Former RVAAP
Portage/Trumbull Counties, Ohio

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The MRS extends from the footprint of former Igloo 7-D-15 in the "D" Block storage bunker area to the east into the "E" Block storage bunkers that are actively used and readily accessible by facility personnel. The MRS crosses several roadways in the igloo areas, but the surrounding area is undeveloped. The surface water and saturated areas at the MRS are either forested wetlands or wet fields with shallow water depths (i.e., less than 3 feet deep). These areas are not physically restricted and are readily accessible to all likely receptors. Once on the MRS, receptors would have access to any MEC on the ground surface or sediment in the saturated and surface water areas. Receptors would have access to subsurface MEC via intrusive activities. The maximum exposure depth in subsurface soil for the Industrial Receptor is 4 feet bgs, which is greater than the maximum depth that MEC was found during the RI field work (6 inches bgs). Based on the soil types and climate conditions at the MRS, any MEC within 30 inches of the ground surface is considered as being susceptible to freeze-thaw cycling, which may ultimately result in subsurface MEC reaching the ground surface. Due to the abundance of low-lying vegetation and the low potential for soil erosion at the MRS, any MEC that may become exposed on the ground surface is not expected to mobilize (CB&I, 2015).

2.1.1.4 MEC Exposure Conclusions

Although no MEC was found on the ground surface, the presence of MEC in subsurface soils strongly suggests that MEC most likely exists on the ground surface at uninvestigated locations. The complete exposure pathway for MEC on the ground surface at the Block D Igloo MRS would be to handle or tread underfoot for all receptors (CB&I, 2015).

Subsurface MEC were encountered during the RI at depths less than 1 foot bgs. Based on these results, the MEC exposure pathway for subsurface soil (greater than 0 inches bgs) is considered complete for all receptors that may engage in intrusive activities while using the MRS. Any buried MEC at the MRS may eventually become exposed due to freeze/thaw cycling.

The presence of MEC in the surface water and saturated areas was not confirmed during the RI; however, these areas are relatively shallow (i.e., less than 3 feet deep). If MEC is present in these areas, any receptors accessing these areas may come into contact with it by walking or handling if picked up. Therefore, the MEC exposure pathway for sediment in the saturated and surface water areas at the MRS is considered potentially complete. The MEC CSM for the Block D Igloo MRS is presented on Figure 2-2.

2.1.2 MC Exposure Pathway Analysis

The RI confirmed that no known or suspected MC risk exists at the MRS, including evaluation for the Unrestricted (Residential) Land Use, and the MC exposure pathway for receptors is incomplete.

2.2 Problem Identification

MEC was found during the RI field work, and the presence of an explosive hazard at the MRS is confirmed. Based on the results of the RI and the history of the MRS as the location where the accidental detonation of 2,516 clusters of M-41 20-lb fragmentation bombs occurred, the probability exists for residual MEC to be present on the surface and in the subsurface as well as in sediment in the saturated and surface water areas at the MRS. The presence of the MEC represents a potential explosive risk to the Industrial Receptor that has a maximum exposure depth of 4 feet bgs in subsurface soils and may access the surface water and saturated areas at the MRS.

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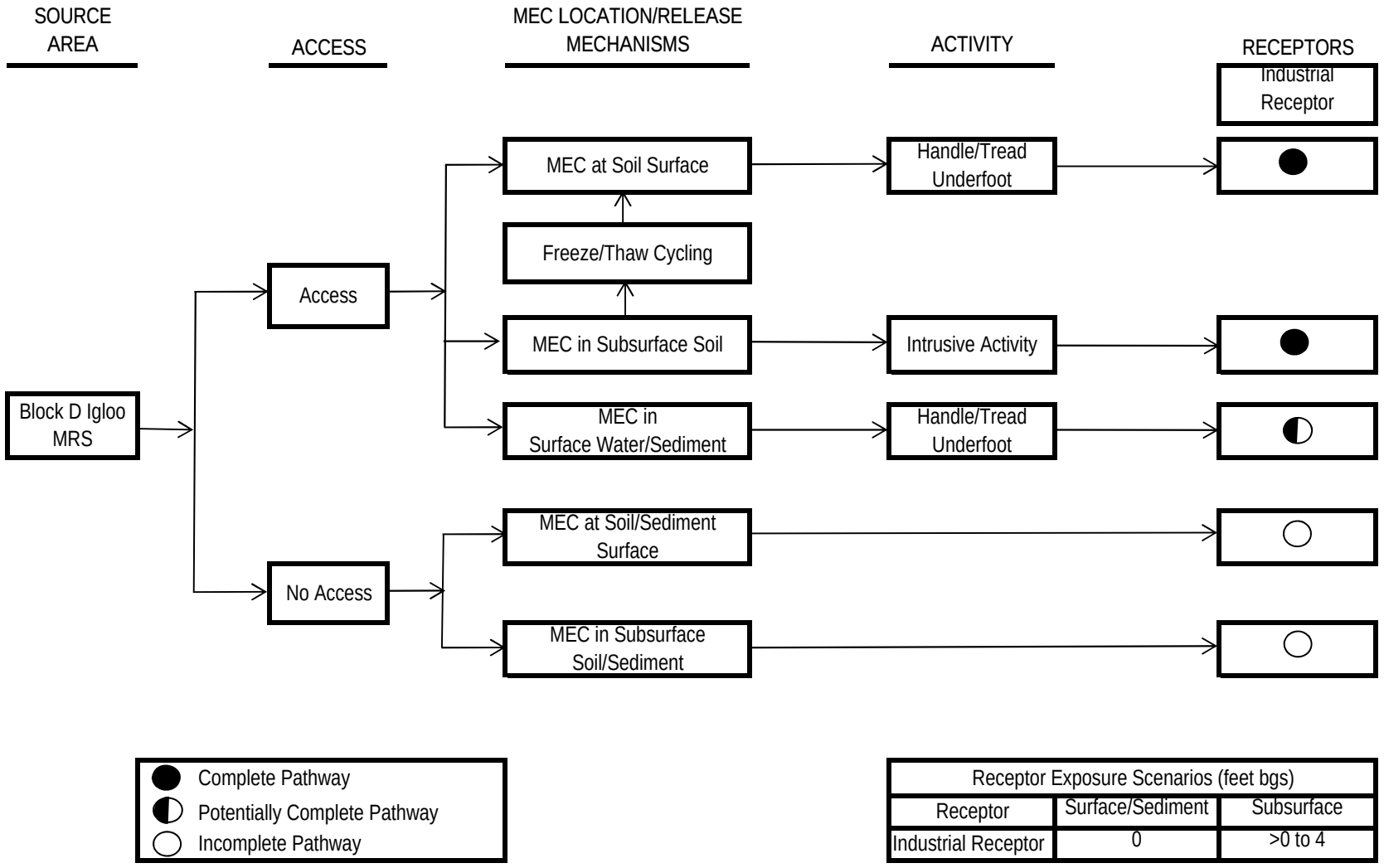
FIGURE 2-2. MEC CONCEPTUAL SITE MODEL
RVAAP-060-R-01 BLOCK D IGLOO MRS



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

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2.3 Preliminary Identification of ARARs and "To Be Considered" Information

Under Section 121 (d)(2)(A) of CERCLA, remedial actions must meet a level and standard of control that attains 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 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 follows:

> "…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 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

Must be environmental or facility siting laws

Are substantive requirements

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 when chemical-specific ARARs are not sufficiently protective to develop remediation goals. There is no known or suspected MC risk at the MRS. Therefore, there are no chemical-specific ARARs identified for the MRS.

2.3.2 Location-Specific ARARs

Location requirements include those established for potential remedial activities conducted within wetlands or a floodplain area, or with respect to threatened and endangered species. Generally, for wetlands and floodplains, rules require that alternatives to remedial activity within the sensitive area be pursued, and if that is not feasible, then adverse effects from any actions taken within the sensitive area be mitigated to the extent possible. The *Endangered Species Act* (ESA; 16 USC Chapter 35§1532 et seq.) exists to protect the habitat of flora and fauna that are threatened or endangered and halt and reverse the trend toward species extinction. The potential ARARs considered for remedial action at the MRS are summarized in Table 2-2.

Under CERCLA Section 121(d), relevance and appropriateness are related to the circumstances presented by the release of hazardous substances, with the goal of attaining a degree of cleanup and control of further releases that ensures the protection of human health and the environment. Location requirements for wetlands and floodplains, as well as requirements of the ESA, do not relate to the degree of cleanup as much as they relate to protecting sensitive areas and threatened and endangered species from effects of remedial activities. They do not further the degree of cleanup in the sense of protecting human health or the environment from the effects of harmful substances or hazardous items. The purpose of the location rule requirements does not address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited as an ARAR; that is, the rule requirements are not sufficiently relevant and appropriate under CERCLA Section 121(d) as related to the circumstances of the release, degree of cleanup, or protectiveness of remedial action, to include these requirements as ARARs.

Section 404 of the *Clean Water Act of 1977* (CWA) governs the discharge of dredged and fill material into waters of the U.S., including adjacent wetlands. Wetlands are areas that are inundated by water frequently enough to support vegetation typically adapted for life in saturated soil conditions. A stream and planning and jurisdictional wetlands have been identified within the boundary of the Block D Igloo MRS through wetland surveys (OHARNG, 2014). The EPA has jurisdiction over wetlands and the Section 404 guidelines are promulgated in 40 CFR§230. These regulations stipulate that degradation or destruction of wetlands and other special aquatic sites should be avoided to the extent possible. No discharge of dredged or fill material is permitted if there is a practicable alternative to the proposed discharge that would have less adverse impact on the aquatic ecosystem, as long as the alternative does not have other significant environmental consequences (40 CFR§230.10[a]). Pursuant to 40 CFR§230.10(b), no discharge of dredged or fill material is allowed if the discharge (1) causes or contributes to violations of any additional State water quality standard, (2) violates any applicable toxic effluent standard or discharge prohibition under CWA Section 307, (3) jeopardizes endangered or threatened species specified under the ESA, or (4) violates requirements to protect a marine protection sanctuary designated under Title Ill of the *Marine Protection, Research, and Sanctuaries Act of 1972*.

Additionally, CERCLA response actions are not subject to permit requirements as provided under CERCLA Section 121(e), 42 USC§9621(e) and in accordance with Nationwide Permit 38 promulgated under 33 CFR§320, Camp Ravenna is not required to obtain a permit under the CWA. Discharge to wetlands is only anticipated if MEC is identified within a wetland and fill activities are necessary to access the MEC. If these activities are deemed necessary then the requirements in Section 404 of the CWA may be considered relevant and appropriate and Camp Ravenna would comply with the substantive requirements of the Nationwide Permit. Camp Ravenna-specific guidelines related to the protection of wetlands and threatened or endangered species would be followed during remedial activity. The facility *Integrated Natural Resources Management Plan* (INRMP) (OHARNG, 2014) wetland and floodplain guidelines state that Camp Ravenna will minimize the destruction, loss, or degradation of wetlands.

Table 2-2. Summary of Potential ARARs

Requirement	Citation	Description	Applicable	Relevant and Appropriate	Comments
Chemical-Specific ARARs					
None. MC not identified.					
Location-Specific ARARs					
Clean Water Act, Section 404	40 CFR§230.10	Governs the discharge of dredged and fill material into waters of the United States, including adjacent wetlands.	No. Only applicable to the substantive requirements. Action at the MRS is being conducted under CERCLA, so a permit is not required. Discharge of dredged material or fill is not currently anticipated but could be necessary if MEC is identified within the wetlands.	Yes. Excavation and removal of MEC within a wetland may require filling to access location.	Maybe relevant and appropriate if filling activities are necessary under any alternative for removal of MEC within a designated wetland.
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. Land is not being developed for non-farm commercial, industrial, residential, or other non-farm purposes.	Yes. Excavation and removal of MEC disturb the land surface, which may contribute to erosion and sedimentation.	May be relevant and appropriate to any alternatives involving the removal of MEC that disturbs the soil and contributes to erosion and sedimentation.

ARAR denotes applicable or relevant and appropriate requirement.
CFR denotes Code of Federal Regulations.
MEC denotes munitions and explosives of concern.
MRS denotes Munitions Response Site.
OAC denotes Ohio Administrative Code.
USC denotes United States Code.

There are no federal-listed species or critical habitats at the Block D Igloo MRS based on the facility INRMP (OHARNG, 2014). Although biological inventories have not been completed specifically for the MRS, a state-listed species of concern consisting of the sharp-shinned hawk has been observed within its boundaries (CB&I, 2015) The Northern long-eared bat is a federally threatened species that was found at Camp Ravenna and is now listed for the facility. There are vegetation cutting restrictions in place for Camp Ravenna during the Northern long-eared bat summer roosting season, which is between April 1 and September 30. The vegetation cutting restrictions are also applicable for ground and forest-nesting birds at Camp Ravenna that includes the sharped-shinned hawk (OHARNG, 2014). The primary restriction is that vegetation/trees greater than 3 inches in diameter may not be cut during this period. Any action taken by the Federal Government must be conducted in accordance with requirements established under the ESA, even though this law does not establish standards, requirements, limitations, or criteria relating to the degree of cleanup for contaminants remaining at the MRS at the close of the response actions and is not considered as an ARAR.

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. These 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 potential ARARs considered for remedial action at the Block D Igloo MRS are summarized in Table 2-2.

2.4 Remedial Action Objectives

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 MEC (U.S. Army, 2009). RAOs specify the contaminant(s) and media of concern, potential exposure pathways, and the remediation goals (40 CFR§300.430[e][2][i]). The RAOs for the MRS address the overall goal of managing the potential residual explosive hazards and protecting human receptors from these hazards. This FS addresses the potential for explosive hazards from residual MEC remaining at the Block D Igloo MRS. Primary media of concern at the MRS are surface and subsurface soil between ground surface to 4 feet bgs, the maximum exposure depth for the Industrial Receptor. The maximum depth of MEC that was found during the RI was less than 1 foot bgs which is less than the maximum exposure depth of 4 feet bgs. The Industrial Receptor is considered the representative receptor for the current and future land uses including receptors that may access the sediment at the saturated and surface water areas. The saturated and surface water areas at the MRS are relatively shallow (i.e., less than 3 feet) and seasonal fluctuations in water levels may result in the potential for the Industrial Receptor to come into contact with MEC on the sediment surface by walking or handling if picked up. Based on the Industrial Receptor exposure scenario in relation to the maximum depth recoveries for MEC during the RI and the CSM presented in Figure 2-2, the following RAOs were developed for the Block D Igloo MRS:

Reduce the unacceptable potential hazard of MEC on the ground surface and in sediment at the saturated and surface water areas within the MRS to address the likelihood of exposure to the Industrial Receptor via direct contact such that the likelihood of encounter is negligible.

Reduce the unacceptable potential hazard of MEC to a depth of 4 feet bgs within the MRS to address the likelihood of exposure to the Industrial Receptor via direct contact such that the likelihood of encounter is negligible.

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

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 Camp Ravenna. 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, OHARNG/Camp Ravenna, 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 the OHARNG/Camp Ravenna. The OHARNG/Camp Ravenna has the willingness and authority to implement LUCs.

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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 MEC at the Block D Igloo MRS in accordance with the EPA guidance (1988), the NCP (EPA, 1990), and the *Final United States Army Munitions Response Program 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 Block D Igloo 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:

Identification of the MRS area containing MEC based on the RAOs

Identification of GRAs to achieve the RAOs

Identification of 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 demolition of MEC, LUCs, or combinations of these actions. Under CERCLA, evaluation of a "No Action" GRA 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 a remedy where no active remediation or enforceable LUCs are implemented. The DERP Manual (DoD, 2012) requires the DoD component to include at least three GRAs, including No Action, an action to remediate to unlimited use/unrestricted exposure (UU/UE), and an action to remediate a MRS to a protective condition that uses LUCs. The following GRAs have been identified and are considered for the Block D Igloo 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 explosive hazards associated with the MEC present on the MRS. The development and screening of LUCs for this MRS are presented in the IA (Appendix A). The LUCs retained from the initial screening in the IA are evaluated in the FS.

MEC Detection—Detection technologies involve the locating of hazardous items (i.e., MEC) in the environment. Detection is generally used in conjunction with removal and demolition to meet RAOs, but can also be used to identify areas for LUCs. Detection process options examined were digital geophysical mapping (DGM), advanced classification (AC), and analog identification of anomalies.

MEC Removal—This GRA includes physical removal of MEC to reduce its potential impact on the public and the environment. Removal technologies involve the movement of hazardous items (i.e., MEC) from the source area to another location either on or off the MRS. Removal can mitigate exposure pathways; however, it has no effect on the hazardous nature or quantity of MEC. Removal

is used in conjunction with demolition of MEC to meet RAOs. Removal process options examined included in-situ excavation and ex-situ sifting.

MEC Demolition—This GRA implements physical measures, such as destruction via intentional detonation, to reduce the explosive hazard if MPPEH found is verified as material documented as an explosive hazard (MDEH) (i.e., MEC).

Containment—This GRA includes technologies that reduce the mobility or accessibility of MEC. These types of technologies do not address the hazardous nature or quantity of MEC.

With the exception of the No Action alternative, the GRAs identified above may be combined to develop remedial action alternatives for the Block D Igloo MRS. Section 3.2 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 MEC 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 over time.

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 MRS and MEC hazards. The types and concentrations of the MEC 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 for the MRS. Those that are not technically feasible at the MRS are immediately screened out of further consideration.

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:

FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
RVAAP-060-R-001 BLOCK D IGLOO MRS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
NO ACTION	NONE	NONE	No actions are taken to meet Remedial Action Objectives.	Detailed evaluation required by NCP.
LAND USE CONTROLS	ENGINEERING CONTROLS	FENCES	Mechanisms that physically restricts or discourages access to the MRS.	Potentially applicable to any alternative where LUCs will be implemented.
		WARNING SIGNS	Placed around the perimeter of the MRS to provide notice to potential trespassers of the safety hazards and restrictions.	Potentially applicable to any alternative where LUCs will be implemented
		SIEBERT STAKES	Reflective markers that are placed around the perimeter of the MRS to mark the boundaries of sensitive, hazardous, or contaminated areas.	Potentially applicable to any alternative where LUCs will be implemented
	LEGAL MECHANISMS	MONITORING	Visual and physical inspections that evaluate physical changes (e.g., missing signs, unwanted/overgrown vegetation, holes in fences, etc.) that may require maintenance or repairs.	Potentially applicable to any alternative where LUCs will be implemented.
	EDUCATIONAL CONTROLS	EDUCATIONAL CONTROLS	Programs geared toward notification of existing conditions, existing engineering controls, and potential hazards.	Potentially applicable to any alternative where LUCs will be implemented.

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FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
RVAAP-060-R-001 BLOCK D IGLOO MRS

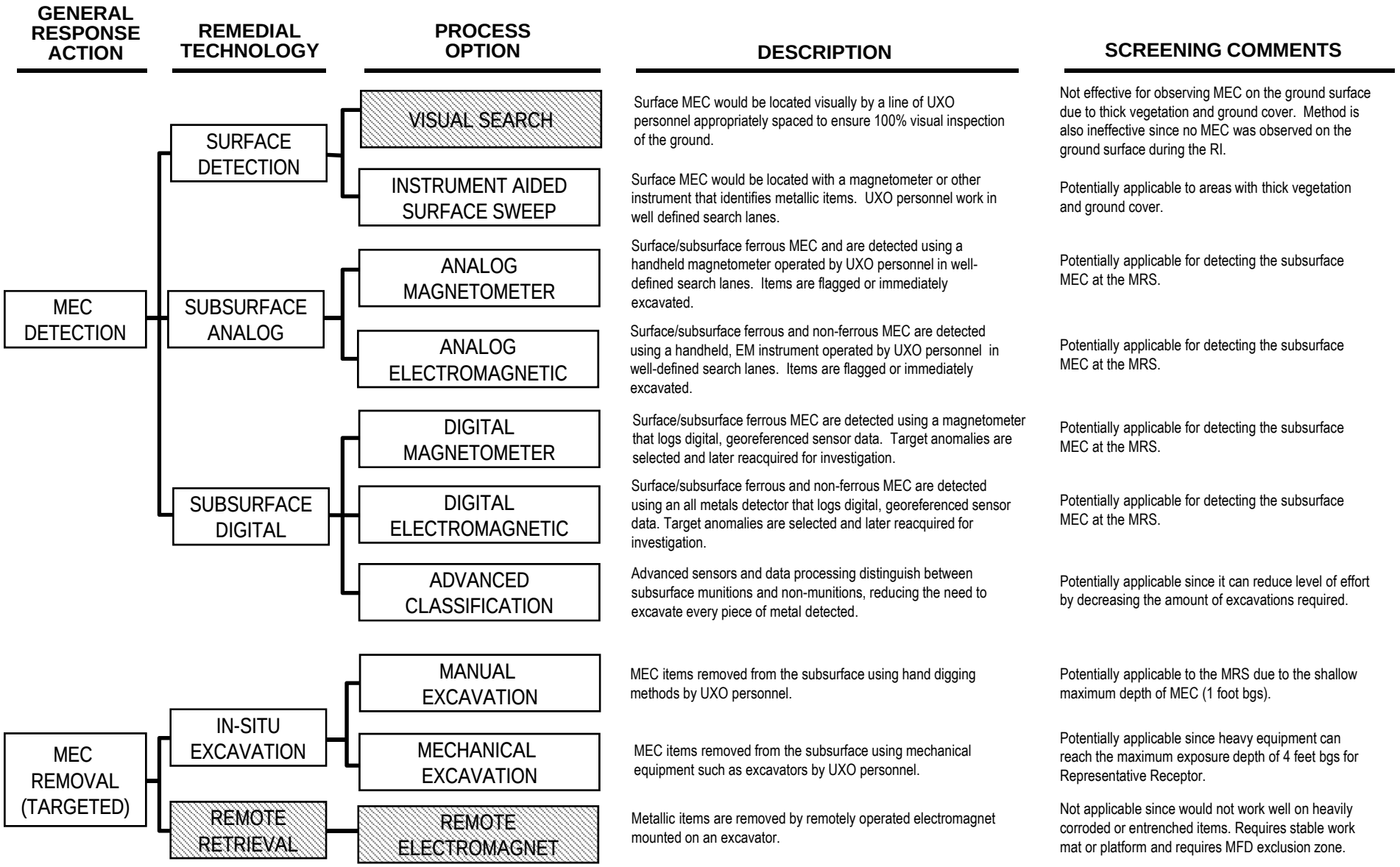

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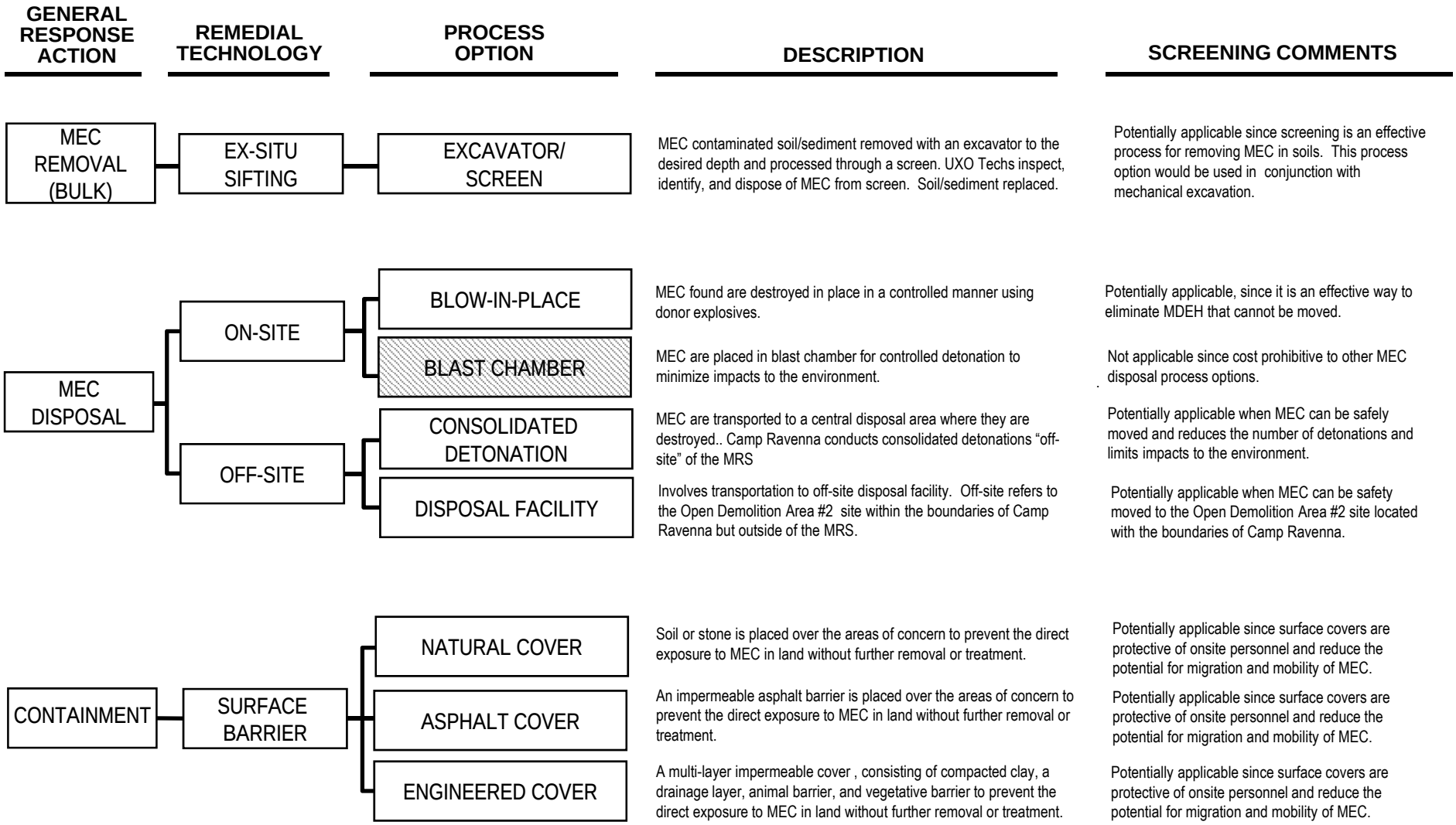
FIGURE 3-1. PRELIMINARY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS
RVAAP-060-R-001 BLOCK D IGLOO MRS



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Effectiveness—The technology 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 MEC 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 MEC and the conditions at the MRS (EPA, 1988).

Implementability—Implementability is the ability of the technology to be executed 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 off-site actions as well as the availability of treatment, storage, and demolition services (including capacity), and the availability of necessary equipment and skilled workers to implement the technology (EPA, 1988).

Cost—Cost is the relative price 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 medium relative to other options within the same technology type. If two options are determined to provide equal benefits with regard to effectiveness and implementability, the higher-cost option is eliminated from further analysis (EPA, 1988).

Figure 3-2 further screens the identified technologies and process options 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 explosive hazards 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 MEC. Instead of direct elimination of MEC, LUCs rely on behavior modification and/or access control strategies to reduce or eliminate risk. 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.

Engineering Controls

Engineering controls are physical structures or mechanisms that warn of hazards or prevent access to the MRS. The engineering controls retained following the preliminary evaluation include fencing, signage, and Seibert stakes.

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FIGURE 3-2. EVALUATION OF PROCESS OPTIONS
RVAAP-060-R-01 BLOCK D IGLOO MRS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NONE	Does not mitigate potential explosive hazards	Technical feasibility does not apply as no actions are required; however, not administratively feasible as no reduction in explosive hazards occur.	Capital: None O&M: None
LAND USE CONTROLS	ENGINEERING CONTROLS	FENCES	Effective at keeping trespassers out of MRS.	Readily implemented and administratively feasible for Camp Ravenna if restricted access is required to protect trespassers from an area with a high explosive hazard.	Capital: High O&M: Med
		WARNING SIGNS	Effective at notifying potential trespassers of hazards and cautioning of restricted use or access. Would be less effective in wooded areas where potential trespassers may not see the signs.	Readily implemented and administratively feasible for Camp Ravenna. Can be used in conjunction with other physical mechanisms such as fencing or Siebert stakes.	Capital: Low O&M: Low
		SIEBERT STAKES	Effective at alerting potential trespassers of the MRS boundaries. Would be less effective in wooded areas where potential trespassers may not see the markers.	Readily implemented and administratively feasible for Camp Ravenna at areas with there is a moderate to low explosive hazards	Capital: Med O&M: Mod
	LEGAL MECHANISMS	MONITORING	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
	EDUCATIONAL CONTROLS	EDUCATIONAL CONTROLS	Effective in training authorized personnel entering an MRS to recognize and avoid MEC hazards. This measure is only effective for authorized personnel.	Readily implemented but requires experienced personnel to provide training. This is administratively feasible as Camp Ravenna already conducts training as an interim control.	Capital: Low O&M: Low

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FIGURE 3-2. EVALUATION OF PROCESS OPTIONS
RVAAP-060-R-01 BLOCK D IGLOO MRS

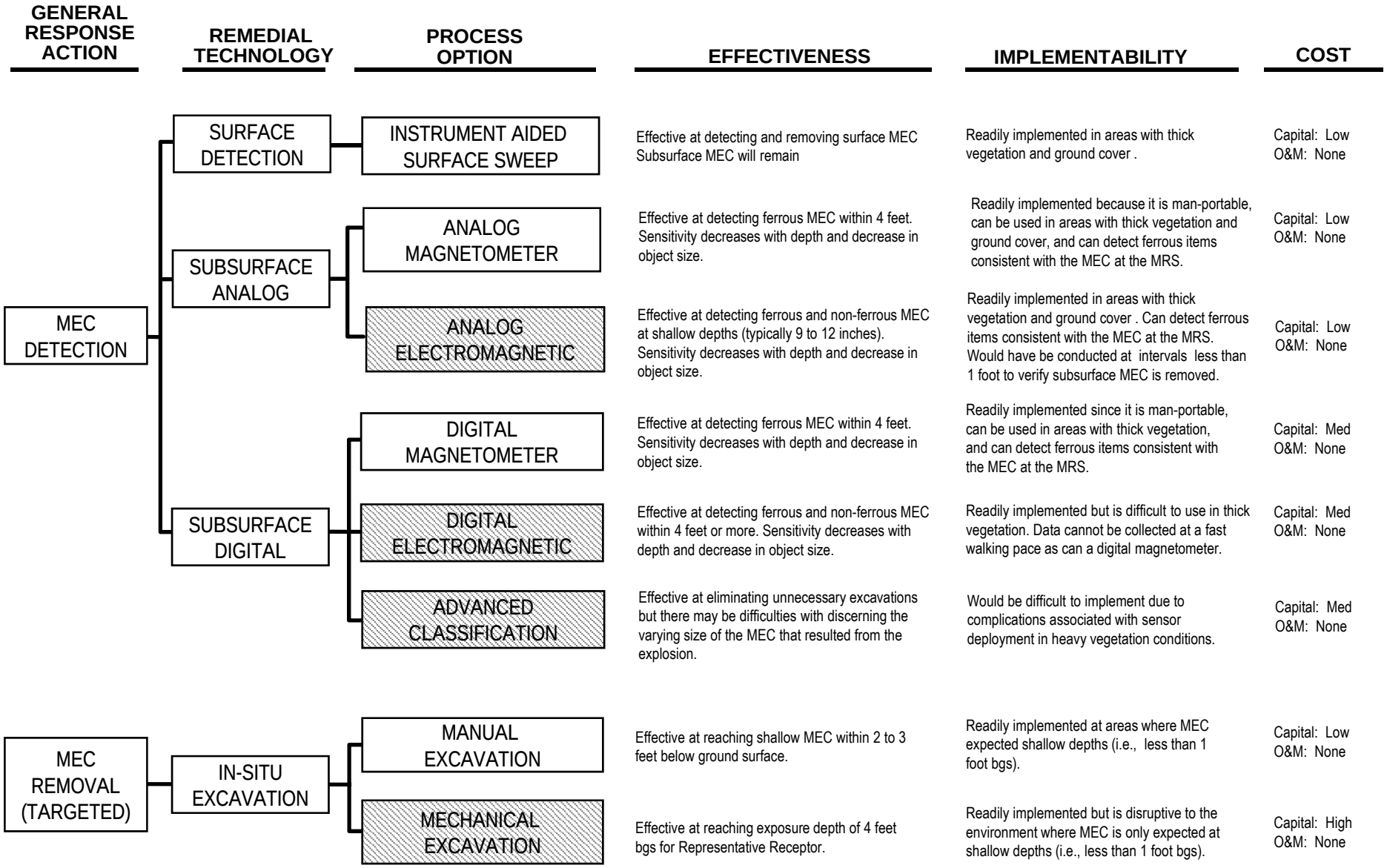

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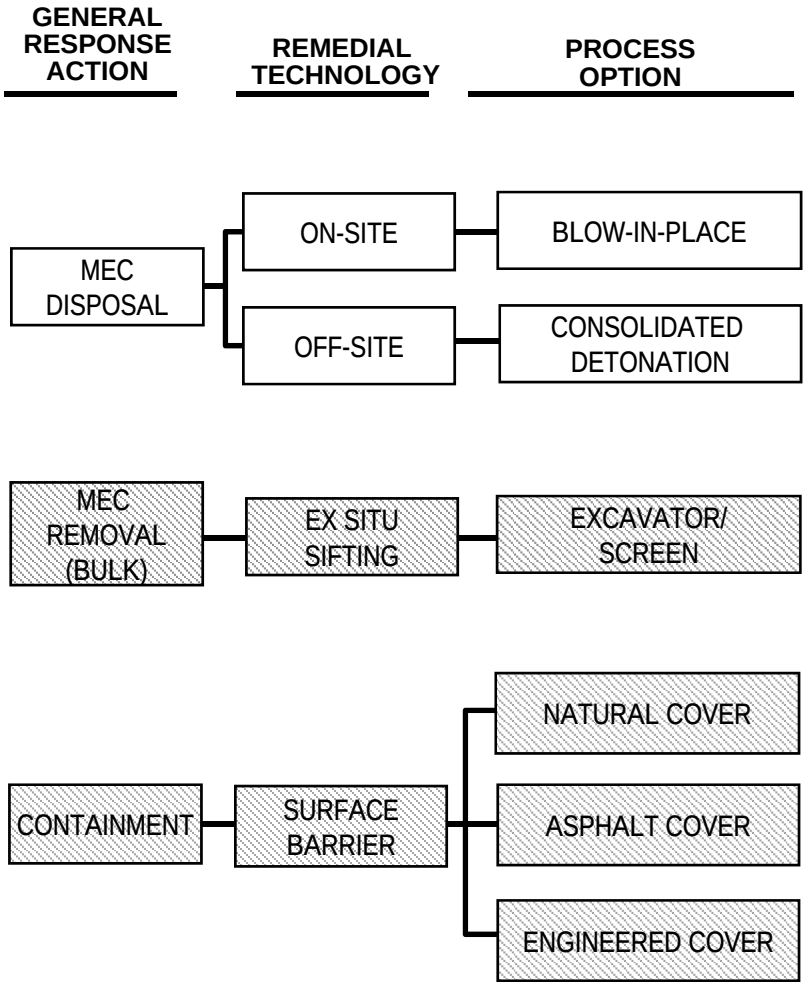
FIGURE 3-2. EVALUATION OF PROCESS OPTIONS
RVAAP-060-R-01 BLOCK D IGLOO MRS



EFFECTIVENESS	IMPLEMENTABILITY	COST
Effective at eliminating MEC from the MRS.	Readily implemented and is administratively feasible. Camp Ravenna currently coordinates MEC requiring blow-in-place with Explosive Ordnance Disposal.	Capital: Low O&M: None
Effective at eliminating MEC from the MRS	Readily implemented and is administratively feasible. Camp Ravenna currently conducts consolidated detonations at Open Demolition Area #2.	Capital: Low O&M: None
Effective at removing MEC in excavated soils..	Readily implemented and administratively feasible but is more appropriate to use when large volumes of soils are to be removed which is not the case for the MRS.	Capital: High O&M: None
Effective at preventing direct exposure to MEC and reduces the potential for migration and mobility of MEC. Does not remove the MEC	Readily implemented but not administratively feasible, as it requires routine inspections. Impact to the environment is not acceptable to Camp Ravenna.	Capital: Low O&M: High
Effective at preventing direct exposure to MEC and reduces the potential for migration and mobility of MEC. Does not remove the MEC.	Readily implemented but not administratively feasible, as it is not consistent with surrounding uses at Camp Ravenna.	Capital: Med O&M: Med
Effective at preventing direct exposure to MEC and reduces the potential for migration and mobility of MEC. Does not remove the MEC.	Readily implemented but not administratively feasible, as it requires routine inspections. Impact to the environment is not acceptable to Camp Ravenna.	Capital: High O&M: High

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Fencing

Fencing would be used to physically restrict or discourage access to the MRS. The effectiveness of the fence would depend on the size, type, and maintenance of the fence. The main advantage to a fence is that it prevents inadvertent access. Fencing can be used in conjunction with other engineering controls such as signage to provide additional assurance that receptors are aware of the hazards at the MRS. The installation of fencing would meet the RAOs since it would be effective at reducing the unacceptable potential hazard of receptors from encountering the MEC at the MRS; however, fences require inspection, maintenance, and repair to remain effective. Fencing is a reliable process option and has historically been used throughout Camp Ravenna to deter access to potentially hazard and/or physically dangerous areas. This process option is technically feasible to implement since the services, materials, and workers necessary to construct fencing around the MRS are readily available. The OHARNG/Camp Ravenna would be amenable to constructing a fence around the MRS if restricted access was necessary to protect receptors from potential explosive hazards; therefore, this process option is administratively implementable. The cost for the materials and services associated with the installation and upkeep of this process option is higher in comparison to other engineering controls such as signage or Siebert stakes alone.

Signage

Warning signs would be posted to provide potential receptors with immediate awareness of the risks and safe practices. Such signs would warn that the area is restricted and that unauthorized personnel are not permitted to enter. The installation of warning signs would meet the RAOs since they would be effective at reducing the unacceptable potential hazard of receptors from encountering the MEC by cautioning potential receptors about the hazards at the MRS. The warning signs would likely be less effective in the heavily wooded areas of the MRS and would need to be used in conjunction with fencing and/or Siebert Stakes depending on the hazard level identified for the MRS or if restricted access was necessary. The signs would require inspection, maintenance, and periodic replacement to remain effective. The placement of warning signs is a reliable process option and has historically been used throughout Camp Ravenna to discourage access to potentially hazard and/or physically dangerous areas. This process option is technically feasible to implement since the services, materials, and workers necessary to install warning signs around the MRS are readily available. Warning signs are currently used at Camp Ravenna to caution personnel of hazardous area; therefore, this process option is administratively implementable. The cost for the materials and services associated with the installation and upkeep of this process option alone is low in comparison to other engineering controls such as fencing or Siebert stakes.

Siebert Stakes

Seibert stakes are red and yellow reflector markings that are installed at the top of metal posts to indicate the boundary of a specific area. The stakes are typically used within military training areas and are installed at a predetermined spacing to mark the boundaries of sensitive, hazardous, or contaminated areas that are off limits to training or maneuver activities. Siebert stakes may be used in conjunction with signage that would warn that the area is restricted and that unauthorized personnel are not permitted to enter. The installation of Siebert stakes would meet the RAOs since they would be effective at reducing the unacceptable potential hazard of receptors from encountering the MEC by alerting potential receptors regarding the boundaries of the MRS. The stakes would be less effective in the heavily wooded area of the MRS where unknowing receptors may not see the stakes and mistakenly enter the MRS. Siebert stakes would require inspection, maintenance, and periodic replacement to remain effective. The use of Siebert stakes is a reliable process option and are currently in use at other MRSs at Camp Ravenna as an interim control until final remedial alternatives are developed. This process option is technically feasible to implement since the services,

materials, and workers necessary to install Siebert stakes around the MRS are readily available. The OHARNG/Camp Ravenna would be amenable to installing Siebert stakes to protect receptors from entering an MRS where potential explosive hazards at the MRS are present but are considered moderate or low; therefore, this process option is administratively implementable. The cost for the materials and services associated with the installation and upkeep of this process option is moderate in comparison to other engineering controls such as fencing (higher costs) and warning signs (lower costs).

Monitoring

Monitoring (i.e., inspections) 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. Examples of monitoring activities include UXO-qualified escorts periodically conducting enhanced visual surveys. These activities ensure early identification and response for any MEC. The process option meets the RAOs, since it would be effective at reducing the unacceptable potential hazard of MEC 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 experienced and readily available UXO personnel to make regular visits to the MRS for inspections. It is not administratively feasible to the OHARNG/Camp Ravenna 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 MEC exposure) is achieved.

Educational Controls

Educational controls would include programs that notify visitors, Camp Ravenna personnel, contractors, and utility workers of existing conditions, existing engineering controls, and potential hazards. Training (e.g., LUC awareness, hazard recognition, and reporting procedures) informs property users of the potential presence of MEC, stressing the importance of the "Rs"—Recognize, Retreat, and Report. Educational controls can be implemented to provide informational materials on potential MEC recognition, avoidance and encounter protocols.

LUC awareness training is the Camp Ravenna-specific training provided to authorized individuals accessing the MRS. The training is described in the *Draft Final Property Management Plan* (USACE, 2017) for Camp Ravenna or the most current version. Training provides an overview of the requirements in the 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 most current version of the *Property Management Plan* would be updated to include a summary of LUCs developed specifically for this MRS.

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

Summary of Land-Use Controls Process Options

The engineering controls LUCs consisting of fencing, warning signs, and Siebert stakes and the educational control LUC are retained for further evaluation since they are determined to be effective, implementable, and at reasonable cost. These engineering control LUCs can be used alone or in conjunction with one another

depending on the restricted access requirements at the MRS following the remedy implementation. It is not administratively feasible to the OHARNG/Camp Ravenna to conduct exposure monitoring for occupational hazards to trainees accessing the MRS; however, annual monitoring (i.e., inspections) that evaluates the conditions at the MRS and ensures that the engineering and educational 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.

3.2.3 MEC Detection

MEC detection involves those methods and instruments used to locate munitions items in the environment. Detection can include a broad-scale investigation to locate areas where MEC is densely clustered, or a focused-scale investigation to locate individual MEC. Detection is normally used in conjunction with removal and MEC demolition to meet RAOs, but can also be used to identify areas for containment and/or LUCs.

Current state-of-the-art detection methods cannot detect all MEC. Some technologies can only detect MEC that is on the surface, and those that can detect buried MEC have depth limitations. Most methods are better suited for land-based detection applications rather than underwater detection. In general, the deeper the MEC are buried and the smaller they are, the harder they are to detect. MEC detection remedial technologies and process options are discussed below. The remedial technologies for MEC detection include surface detection, subsurface analog, and subsurface digital methods. The MEC detection process options retained for further evaluation include instrument-aided surface sweeps and subsurface analog and digital detection instruments.

Surface Detection

A variety of process options may be employed to detect MEC on the ground surface and in the shallow surface water areas at the MRS. Following the preliminary evaluation, the instrument-aided surface sweep was retained for further evaluation at the MRS.

Instrument-Aided Surface Sweep

Instrument-aided surface sweep would consist of a systematic search for surface MEC with a subsurface detection instrument. This process option is applicable for detecting surface MEC and can also be used in shallow surface water (i.e., less than 3 feet). UXO-qualified personnel would work in well-defined search lanes that cover the entire land and water areas at the MRS. This approach is necessary where thick vegetation or other ground cover is present, as is the case for the Block D Igloo MRS. It would be effective at detecting residual MEC on or just below the ground or sediment surface, but would not be as effective at detecting smaller MEC at deeper intervals. For instrument-aided surface sweeps at the terrestrial portions and very shallow surface water areas (generally less than 1 foot deep) at the MRS, the detection instrument would be the Schonstedt GA52-CX, or similar instrument, that is light, compact, and highly implementable at the MRS. A Mag 1 underwater magnetometer, or similar instrument, may be used in areas with water depths greater than 1 foot. There is the potential for short-term effects from this process option for the UXO-qualified personnel due to the hazards associated with MEC at the MRS. Instrument-aided surface sweep is a proven and reliable option and was used at terrestrial and wetland areas of the MRS during the RI. The materials and equipment for this process option are readily available; however, UXO-qualified personnel would be required to conduct the sweep due to the potential for encountering MEC. Permission to conduct the instrument-aided surface sweep would be easily obtained from the OHARNG/Camp Ravenna, since it presents little disturbance to the environment and makes this process option administratively implementable.

There is minimal equipment required, and the rental costs for the detection equipment are relatively low. The sweep activities can be conducted quickly, depending on the ground cover conditions or sediment thickness, which further reduces costs. There are no O&M costs associated with this process option.

Subsurface Analog Detection

Subsurface analog detection consists of hand-held analog geophysical instruments that are used in sweep mode as the instrument is passed back and forth by UXO-qualified personnel following well-defined search lanes of 5 feet wide or narrower. Analog instruments emit an audible signal as the instrument is moved past an anomaly. The UXO-qualified personnel progress along the search lane and stop when an anomaly is encountered. Anomalies identified are either flagged or immediately excavated. The subsurface analog detection process options that were retained following the preliminary evaluations were both the analog magnetometer and electromagnetic (EM) instruments.

Analog Magnetometer Instruments

Analog magnetometer instruments detect irregularities (anomalies) in the earth's magnetic field due to the presence of surface and/or subsurface ferrous items. A gradiometer consists of two or more magnetometer sensors configured to measure the spatial rate of change in the magnetic field. An analog version of a magnetometer/gradiometer emits an audible signal that changes in pitch as the instrument is moved past a metallic item. Owing to its effectiveness, simple operation, and ready availability of hand-held units, magnetometry is the most commonly used technology for locating buried MEC. Analog magnetometers such as the Schonstedt GA52-CX are light, compact, are highly implementable at the MRS, and were used during the RI. The magnetometer would be applicable for the MRS because all the MEC associated with the M-41 20-lb fragmentation bomb is ferrous. The detection depth of analog magnetometer instruments is typically 2 to 4 feet bgs; however, it is expected that the maximum depth of the MEC at the MRS is less than 1 foot bgs, based on the RI. Depending on the size of the detected anomaly, this process option may need to be combined with iterative removal of soil layers to achieve the subsurface RAO depth of 4 feet bgs and the confidence in being able to detect the smallest anticipated size of MEC at the MRS. There is the potential for short-term effects from this process option for the UXO-qualified personnel due to the hazards associated with MEC at the MRS. The method is technically implementable; however, UXO-qualified personnel would be required to investigate and remove any MEC identified. The analog magnetometer is a commonly used instrument for subsurface MEC detection, and permission would be easily obtained from the OHARNG/Camp Ravenna, which makes this process option administratively implementable. The capital cost associated with using the analog magnetometer is lowest among the other subsurface detection technologies. There are no O&M costs associated with this process option.

Analog EM Instruments

Analog EM instruments involve the use of an EM induction system to transmit electrical current. The system measures either the secondary magnetic field induced in metal objects or the difference between the electrical conductivity of the soil and the object. In addition to being able to detect ferrous MEC, analog EM instruments such as the Whites DFX-300 metal detector are capable of detecting non-ferrous MEC. Analog EM instruments are typically limited to a maximum detection depth between 9 to 12 inches bgs and sensitivity decreases further with depth and the size of the anomaly. This process option would need to be combined with iterative removal of soil layers of less than 1 foot to achieve the subsurface RAO depth of 4 feet bgs. The use of analog EM instruments can be time-consuming and labor intensive due to the capability of this method to detect all metal anomalies (i.e., ferrous and non-ferrous) that would require investigation; although, the likelihood of encountering a significant amount of non-ferrous cultural debris is considered to be low. The method is technically implementable; however, UXO-qualified personnel would be required to investigate all

targets identified. Analog EM instruments have been used at Camp Ravenna in the past, and permission to use this instrument type for subsurface detection would be easily obtained from the OHARNG/Camp Ravenna, which makes this process option administratively implementable. The capital cost associated with using analog EM instruments is low in comparison to the other subsurface detection technologies. There are no O&M costs associated with this process option.

Subsurface Digital Detection

As opposed to analog instruments, digital EM instruments log georeferenced sensor data that can be analyzed, processed, and used to identify targets with known location coordinates. Anomalies identified in the data can be analyzed to estimate their size and depth. Anomalies can be classified from most likely to least likely to be the size and shape of munitions known to have been used at the MRS. If done properly with the appropriate quality control, the number of anomalies to investigate may be reduced to create a target anomaly list. Since coordinates are known, the target anomalies can be reacquired and excavated at a later date. Common methods for deploying geophysical sensors are man-portable systems and towed arrays. The main controlling factors for determining the appropriate method is terrain and vegetation coverage. Man-portable systems can be more successfully used in areas of heavy vegetation and more difficult terrains such as the heavily forested areas and wetlands or wet fields at the MRS, whereas towed arrays have more difficulties in areas of rugged terrain or heavy vegetation but afford greater efficiency in open areas. Digital magnetometer instruments and digital EM instruments were retained for further evaluation as subsurface digital detection process options following the preliminary evaluation.

Digital Magnetometer Instruments

Digital magnetometer instruments work on the same principle as analog magnetometers, detecting irregularities (anomalies) in the earth's magnetic field or the spatial rate of change in the magnetic field. Digital magnetometer instruments, such as the Geometrics Model G-858G Cesium Gradiometer, would be applicable because the MEC associated with the M-41 20-lb fragmentation bomb that exploded at former Igloo-7-D-15 is ferrous. Further, this instrument is capable of collecting data at a faster rate than a digital EM instrument. The digital magnetometer instruments are man-portable and would be effective at detecting MEC in the subsurface within 4 feet bgs, which is the maximum exposure depth of the Industrial Receptor at the terrestrial portions of the MRS. Depending on the size of the detected anomaly, this process option may need to be combined with iterative removal of soil layers to achieve the subsurface RAO depth of 4 feet bgs and the confidence in being able to detect the smallest anticipated size of MEC. Digital magnetometer instruments can also detect anomalies in the sediment in areas with shallow surface water, which is applicable to the MRS. There is the potential for short-term effects from this process option for the UXO-qualified personnel due to the hazards associated with MEC at the MRS. This process option can be easily implemented, but would require experienced geophysicists to operate the equipment and analyze the data. UXO-qualified personnel would be required to conduct the investigation of anomalies and removal of MEC. The ability to adequately log the data with the digital magnetometer instruments may be limited at the heavily forested areas at the MRS due the extensive vegetation and tree canopy. The use of digital magnetometer instruments is administratively feasible, since it does not require significant ground vegetation clearance to implement and would be readily agreeable to use by the OHARNG/Camp Ravenna. The rental cost for the materials and services associated with this process option is higher in comparison to other subsurface detection technologies; however, the ability to detect only ferrous targets that are applicable to the MEC at the MRS can significantly reduce the level of effort in the field and; thereby, reduce overall costs. There are no O&M costs associated with this process option.

Digital EM Instruments

Digital EM instruments work on the same principle as analog EM instruments, transmitting electrical current and measuring either the secondary magnetic field induced in metal objects or the difference between the electrical conductivity of the soil and the object. Similar to analog EM instruments, digital EM instruments are capable of detecting both ferrous and non-ferrous MEC. DGM using an EM61-MK2 instrument has been successful at characterizing the lateral and vertical extent of MEC at other MRSs at Camp Ravenna during RI field work. The instruments would be effective at detecting the MEC within 4 feet or more of the subsurface, the maximum exposure depth of the Industrial Receptor at the terrestrial portions of the MRS; however, this process option may need to be combined with iterative removal of soil layers to achieve the subsurface RAO depth of 4 feet bgs and the confidence in being able to detect the smallest anticipated size of MEC. Digital EM instruments are capable of detecting anomalies in sediment in areas with shallow surface water, but they would need to be float-mounted and would not easily access areas with thick vegetation. There is the potential for short-term effects from this process option for the UXO-qualified personnel due to the hazards associated with MEC at the MRS. Additionally, significant vegetation clearing is required for this process option and has the potential to impact wildlife habitats, in particular between April 1 and September 30. This period is considered the nesting season for ground- and forest-nesting birds, including the sharp-shinned hawk, as well as the roosting season for the Northern long-eared bat. This process option can be easily implemented, but would require experienced geophysicists to operate the equipment and analyze the data. UXO-qualified personnel would be required to conduct the investigation of anomalies and removal of MEC. The ability to adequately log the data with the digital EM instrument at the heavily forested areas at the MRS may be limited due the extensive vegetation and tree canopy. The use of digital EM instruments would be administratively feasible to the OHARNG/Camp Ravenna, since the instruments have been used at Camp Ravenna in the past. Any vegetation clearing in support of this process option would require approval and coordination with the OHARNG/Camp Ravenna. The rental cost for the materials and services associated with this process option is lower in comparison to other subsurface detection technologies. The costs associated with this option can increase significantly if there are substantial cultural debris and non-ferrous items that would also require investigation. There are no O&M costs associated with this process option.

Advanced Classification

AC is an evolving geophysics technology that can aid in distinguishing buried munitions from buried non-munitions. Traditional MEC removal actions utilizing DGM follow the process of field survey, data processing, identification of anomalies to create a list of coordinates where buried metal is present, and finally excavation of all metallic anomalies. Typically, MEC makes up less than 1 percent of the detected anomalies, so there is significant effort spent to excavate and remove non-MEC items.

The sensors used for AC are multi-transmitter, multi-receiver EM induction sensors. Parameters extracted from these data indicate the geometry, size, and wall thickness of the metal object. AC sensors are placed over subsurface anomalies to collect data regarding the subsurface item. The data are analyzed, and each anomaly is classified as a potential target of interest, an anomaly that can't be confidently classified, or as clutter of no interest. The percentage of anomalies that can be eliminated is MRS-dependent, but can range from 50 to 75 percent. The reduced list of anomalies is then sent to the UXO teams for investigation.

In sensitive environments such as wetlands at the MRS, using AC can be considered in order to reduce excavations and preserve the natural habitat; however, deployment of these advanced sensors in their current form would be challenging. The two sensors currently available are the Metal Mapper, which is typically vehicle-towed, and the TEMTADS 2×2, which is man-portable. If a waterproof version were developed, it could theoretically be used at the wetland areas of the MRS.

Although implementing AC can provide a significant cost savings due to the reduced list of anomalies that would need to be reacquired, it would not be technically feasible due to the thick vegetation and varying terrain that would make deployment of the sensors difficult. Further, the size of the MEC at the MRS varies and there is no automatic "signature" that would define the MEC; thereby, reducing confidence that the uninvestigated anomalies aren't MEC. As a result, AC would potentially be ineffective since there would be lower confidence in the target anomalies that could be removed from requiring reacquisition through the data analysis. The capital cost associated with using AC instruments is medium in comparison to the other subsurface detection technologies. There are no O&M costs associated with this process option.

Summary of MEC Detection Process Options

Instrument-aided surface sweep is considered the best process option for the surface detection of MEC, as well as the sediment in the saturated and surface water areas at the MRS, since a hand-held instrument can be used to detect for MEC in thick vegetation or areas with ground cover or shallow surface water. This process option would require an analog magnetometer, such as the Schonstedt GA52-CX, or similar instrument, that is capable of detecting the ferrous MEC at the MRS.

AC is not considered appropriate for the MRS for subsurface detection, since it would be difficult to implement due to the vegetation and terrain at the MRS. Further, the size of the MEC at the MRS varies and there is no automatic "signature" that would define the MEC; thereby, reducing confidence that the uninvestigated anomalies are not MEC.

For subsurface detection of MEC at the terrestrial portions of the MRS, use of both analog and digital magnetometers were considered as the most appropriate process options for the MRS. Due to the heavy forest and thick vegetation conditions at the MRS, these process options would be operated in conjunction to detect the subsurface MEC. The digital magnetometer, consisting of a Geometrics Model G-858G Cesium Gradiometer, or similar instrument, would map and log data for analysis at open and less-vegetated areas of the MRS. The analog magnetometer, consisting of a Schonstedt GA52-CX, or similar instrument, would be able to investigate for subsurface MEC at the more heavily vegetated areas that the digital magnetometer could not access or adequately map. Use of the analog and digital EM instruments for subsurface detection were not retained for further consideration, since there would likely be accessibility and detection issues in areas of thick vegetation. The analog magnetometer is more suitable for use at the MRS over an analog EM instrument since analog EM can only detect anomalies at a shallow maximum depth between 9 and 12 inches; whereas, the analog magnetometer can detect anomalies that are much deeper (2 to 3 feet). The digital magnetometer was selected since it is capable of mapping data much faster at a walking pace that the digital EM instruments which results in an increase in costs savings. Instrument-aided surface sweep for surface MEC detection and analog and digital magnetometer instruments for subsurface MEC detection are retained because these process options are effective and implementable, and low to medium in cost.

3.2.4 MEC Removal

Removal technologies involve the extraction of MEC from the source area and moving it to another location either on or off the MRS. Removals are used in conjunction with detection and MEC demolition. If it can be performed safely, removal is generally considered to be the most effective form of remediation for MEC. If MEC is no longer present at the MRS, it can never present an explosive hazard to receptors. This makes MEC removal the best traditional method of protecting potential human receptors in the long term.

The MEC encountered at the MRS during the RI was found at individual locations in the subsurface. The removal of MEC at the MRS can be performed in a targeted fashion, where individual MEC is detected, identified, and removed one at a time in a focused manner. Alternatively, bulk removal can be performed in any potential areas of concentrated MEC that may be encountered. Bulk removal technologies may require implementation of engineering controls or other measures to protect potential human receptors or structures. The preferred technology that was retained following the preliminary evaluation was in situ excavation. The associated removal process options for this technology that were retained for further evaluation were manual and mechanical excavation.

In Situ Excavation

In situ excavation during MEC removal refers to the detection and removal of MEC in the subsurface. The detected MPPEH is left in place with as little disturbance as possible until it is positively identified and its condition in regard to its explosive safety hazard is assessed by UXO-qualified personnel. Only then is a decision made whether the MPPEH is MDAS (i.e., MD) or MDEH (i.e., MEC) that can be moved for off-site detonation or requires blow in-place (BIP).

Manual Excavation

Manual excavation consists of hand-digging methods using hand tools that are performed by UXO-qualified personnel. Manual excavation can reasonably reach the exposure depth of 4 feet bgs for the Industrial Receptor in the terrestrial areas of the MRS; however, the anticipated maximum depth of MEC is less than 1 foot bgs and excavation to 4 feet is not anticipated. Manual excavation in the saturated and surface water areas would be conducted by hand (i.e., tactile investigation) to evaluate an anomaly and whether it would be safe to move. If MEC in the sediment extends vertically to deeper intervals, then it may be entrenched and difficult to manually remove. Digging at the target locations manually can easily access the MEC at the anticipated shallow depths, but this option presents short-term risks to the UXO-qualified personnel due to the hazards associated with MEC. Manual excavation in the saturated and surface water areas present the greatest short-term risk to the UXO-qualified personnel, since visibility is low and would limit them from being able to visually verify the anomaly. Conducting a tactile underwater investigation would be protective of the UXO-qualified personnel, since it follows a proven verification process to aid in determining the type and condition of MEC that is found prior to jarring or moving. The potential effects to non-UXO-qualified personnel could be further mitigated by establishing an Exclusion Zone that ensures they maintain a safe distance beyond the hazardous fragment distance (HFD) from an anomaly when it is being investigated. For the Block D Igloo MRS, the HFD is 67 feet for the M-41 20-lb fragmentation bomb (DoD, 2009). Manual excavation is a proven and reliable process option, since it was previously conducted at the MRS during the RI and was successful at the verification and removal of MEC. The method is technically implementable; however, UXO-qualified personnel would be required to investigate and remove any MEC identified. Permission to conduct manual excavation would be easily obtained from the OHARNG/Camp Ravenna, which makes this process option administratively implementable. Although more time-consuming to implement, the capital cost associated with using manual excavation is low in comparison to heavy equipment, since only hand tools and less vegetation removal are required. There are no O&M costs associated with this process option.

Mechanical Excavation

Mechanical excavation using heavy equipment such as excavators or other earth-moving machinery can be used to excavate subsurface MEC. Digging at the target locations using heavy equipment can easily access and remove the MEC at the anticipated depths, but this option presents short-term risks to the UXO-qualified personnel due to the hazards associated with MEC. These potential effects can be mitigated by establishing an Exclusion Zone that ensures non-UXO-qualified personnel maintain a safe distance. When heavy

equipment is used, the Exclusion Zone increases from the HFD to the maximum fragment distance (MFD) (DoD, 2009). The MFD for the M-41 20-lb fragmentation bomb is 1,634 feet. Excavation using heavy equipment is a proven and reliable process option, since it was previously conducted at other MRSs at Camp Ravenna during RI field work and was successful at the verification and removal of MEC. The use of heavy equipment can be very disruptive to the environment due to removal of vegetation and vehicle tracking. Heavy equipment is effective at reaching MEC near the edges of the saturated and surface water areas at the MRS, but would not be able to access MEC that is out of the reach of the equipment. This method is technically implementable; however, significant vegetation and tree removal would be required in order for the heavy equipment to be able to access the interior portions of the MRS, and UXO-qualified personnel would be required to operate the equipment and investigate and remove any MEC identified. The use of heavy equipment is administratively feasible at the terrestrial portions of the MRS, but would require approval and coordination with the OHARNG/Camp Ravenna to conduct vegetation clearing in support of this process option. Heavy equipment may be difficult to implement near the saturated and surface water areas without extensive engineering controls (pumps, swamp mats), since it would be damaging to the environment, and this process option for the wetlands and unnamed stream at the MRS would not be acceptable to the OHARNG/Camp Ravenna. At these areas, excavation using heavy equipment would likely need to be used in conjunction with manual excavation. The capital cost associated with this process option is high in comparison to manual excavation due to equipment, fuel, installation of armor plating, and maintenance costs associated with using heavy equipment. There are no O&M costs associated with this process option.

Ex Situ Sifting

Ex-situ sifting consists of excavation of contaminated soil to the desired depth for processing through a sifter to screen out the MEC and other debris. This approach is efficient at removing MEC, but is also damaging to the environment since it is used in conjunction with mechanical excavation and is more appropriate to use when large volumes of soils are being excavated. As soil is processed through a screen, UXO-qualified personnel monitor the operation and check the screen for MEC. If MEC is recovered, the UXO-qualified personnel take appropriate steps to segregate and dispose of the items. The sifted soil is then returned to the environment. This process inherently removes and jostles all items before a determination is made that the item is safe to move and shields or barricades would be required to protect the UXO-qualified personnel working at or near the sifter equipment from any hazardous fragments. The use of ex-situ sifting is administratively feasible, but would require approval and coordination with the OHARNG/Camp Ravenna to conduct vegetation clearing and the significant disruption of soils due to mechanical excavation in support of this process option. The capital cost associated with this process option is high in comparison to the manual and mechanical excavation options due to the equipment, setup, fuel, and maintenance costs associated with the sifting equipment. There would be no O&M costs associated with this process option.

Summary of MEC Removal Process Options

The maximum exposure depth at the MRS for the Industrial Receptor is 4 feet bgs. Manual excavation was considered the most appropriate process option for in situ excavation primarily due to the anticipated shallow depth of the MEC (less than 1 foot bgs) and accessibility issues for heavy equipment, such as a backhoe or small excavator, to get to the interior areas at the MRS. The surface water levels in the saturated and surface water areas are shallow (i.e., less than 3 feet), which makes manual excavation using tactile investigation the most appropriate option for the saturated and surface water areas at the MRS. The costs associated with heavy equipment are high in comparison to manual excavation. The use of heavy equipment at the MRS would require significant vegetation and tree removal for the equipment to gain access to the interior portions of the MRS. The heavy equipment would also be disruptive to the environment due to the potential for over-digging and the tracking of equipment, in particular along the edges of the wetlands and unnamed stream

areas. Ex-situ sifting would result in even more disruption to the environment and at a higher cost than mechanical excavation alone since this process option would only be appropriate if large amounts of soils were to be excavated, which is not the case for the MRS. Overall, the shallow depth of MEC at the MRS makes manual excavation a more ideal approach and mechanical excavation is removed from further consideration. Further, manual excavation was the method used during the RI to successfully confirm the presence of MEC at the MRS. Manual excavation for targeted MEC removal in the terrestrial and saturated and surface water areas of the MRS is retained because this process option was determined to be effective, implementable, and lower in cost.

3.2.5 MEC Disposal by Demolition

Any MPPEH found at the MRS would be verified as MDAS (i.e., MD) or MDEH (i.e., MEC) by UXO-qualified personnel. All MD would be drummed and transported for off-site disposal to a facility that is licensed to flash and recycle the MD as scrap metal. All MEC that is found would require disposal by demolition, but would require a preliminary evaluation of the condition of the MEC prior to performing the demolition activities. The MEC demolition process options retained for further evaluation following the preliminary evaluation include BIP for on-site demolition and consolidated detonation for off-site demolition. Neither of these process options involves the transportation of MEC onto public roadways outside the boundaries of Camp Ravenna, which is considered unacceptable to the ARNG and the OHARNG. These demolition technologies for MEC are used in conjunction with removal to comprise a remedial alternative.

On-Site Demolition

For MEC that cannot be moved, BIP is the most common method of MEC demolition and is the safest approach since it does not require moving or transporting the item. Donor explosive charges to be used for BIP of MEC would be delivered as needed. A donor explosive is attached to the MEC and used to trigger a high-order detonation to result in complete destruction. This process option is effective at the complete removal of MEC. There is the potential for short-term effects from this process option to the UXO-qualified personnel, potential human receptors, and the environment due to the hazards associated with MEC. Safety controls would be in place to mitigate the potential impacts. Following BIP, environmental testing and restoration would be required to ensure no MC impacts to the environment. This process option is technically implementable, and the materials and services are readily available; however, UXO-qualified personnel that are experienced in explosive ordnance disposal (EOD) procedures would be required to conduct the BIP activities. The OHARNG/Camp Ravenna would be amenable to eliminating an explosive hazard at the MRS that cannot be moved, and BIP is considered to be administratively feasible. The capital cost associated with BIP is low due to the minimal amount of materials required and the short-term level of effort required to conduct the BIP. There are no O&M costs associated with this process option.

Off-Site Demolition

MEC that is considered acceptable to move would be transported off of the MRS for consolidated detonation. Transport of the MEC would be conducted over the Camp Ravenna roadways and would not utilize public roads outside of the boundaries of Camp Ravenna. The consolidated detonation would occur at the Open Demolition Area #2 site that is within the boundaries of Camp Ravenna, but outside of the MRS boundary. 40 CFR§300.5 and 40 CFR§300.400 explain that “on-site” is considered “the areal extent of contamination and all suitable areas in very close proximity to the contamination that are necessary for implementation of the action.” In this case, that would be the MRS boundary, and consequently MEC demolition at the Open Demolition Area #2, although within the Camp Ravenna boundary, would be defined as “off-site”

Consolidated detonations are controlled detonations of a number of MEC that are acceptable to move and transport to a single disposal site where they are destroyed. Any MEC found during the remedial action and determined as safe to move by the UXO-qualified personnel would be transferred off the MRS to the Open Demolition Area #2 site where the buried explosion module would be used to destroy the MEC. Donor explosive charges to be used for MEC demolition would be delivered as needed. This approach reduces the number of detonations and; therefore, limits impacts to the environment. It also allows for detonations to occur in areas where conditions are favorable for control, evacuation, and access. There is the potential for short-term effects from this process option to the UXO-qualified personnel and the environment due to the hazards associated with MEC. Safety controls would be in place to mitigate the potential impacts. Environmental testing and restoration would be required as part of any consolidated detonations to ensure no MC impacts to the environment. This process option is technically implementable, and materials and services are readily available; however, UXO-qualified personnel that are experienced in EOD procedures would be required to conduct the consolidated detonation activities. Consolidated detonation is the preferred method of MEC disposal at Camp Ravenna and this process option is administratively feasible. The capital cost associated with consolidated detonation is low due to the minimal amount of materials required and the short-term level of effort required to conduct the consolidated detonation. There are no O&M costs associated with this process option.

Summary of MEC Demolition Process Options

Both the BIP and consolidated detonation process options were retained for further consideration for both the on- and off-site demolition of MEC, respectively, since the use of either option is dependent on the condition of the MEC and whether or not it can be moved. Both process options are considered effective for the demolition of MEC and eliminate the need for accessing public roadways for off-site disposal (i.e., outside of Camp Ravenna). Summarily, the BIP and consolidated detonation process options were retained because these process options were determined to be effective, implementable, and relatively low in cost.

3.2.6 Containment

Containment includes technologies that reduce the mobility or accessibility of MEC. Containment technologies may mitigate the migration of MEC from the subsurface to the surface via frost heave. Containment may involve placing a physical barrier between the MEC and potential receptors. These types of technologies do not address the hazardous nature or quantity of MEC; they simply reduce accessibility.

Surface Barrier

Surface barriers minimize direct contact with MEC by authorized personnel or trespassers and reduce the mobility of MEC at the MRS. The surface barrier process options considered are natural, asphalt, and engineered covers.

<u>Natural Cover</u>

A natural cover includes a simple physical barrier of natural material such as soil or stone placed over the MRS. This process option would be effective at limiting or preventing the direct contact of receptors with MEC as well as reduce the mobility of MEC at the MRS. The frost line for northeast Ohio is 30 inches, and MEC were found at a maximum depth of less than 1 foot during the RI; therefore, any natural cover would need to be placed to ensure there isn't a migration potential associated with frost heave. Natural covers are easy to implement. Standard earth-moving equipment can move local soil or stone over the areas with MEC. The MRS will require initial clearing of vegetation and large trees. Maintenance would be required to limit large vegetative growth that could disrupt the cover and to control erosion and scouring. Frequent maintenance

(mowing) would be required. Although natural covers are technically feasible to implement, the level of disturbance to the environment is high and therefore this process option would not be administratively acceptable. The materials and services associated with natural covers are readily available, and the associated capital cost is lower 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 MEC and the potential for migration and mobility of MEC 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 to maintain their effectiveness. Asphalt covers are most effective if the area needs to be asphalted for another use, such as a parking lot or storage area that will promote its long-term maintenance, which is not the case of the MRS. Asphalt covers are easy to install and would require initial clearing of vegetation and large trees. 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. Although technically feasible to implement, installation of an asphalt cover is not consistent with the surrounding land uses at Camp Ravenna and this process option would not be administratively acceptable to the OHARNG/Camp Ravenna. 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 MEC and the potential for the migration and mobility of MEC at the MRS through the installation of impermeable layer materials. Engineered covers can be effective at reducing infiltration that reduces the migration potential for MEC associated with frost heave. 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, as frequent mowing is required. Proper oversight must be provided to prevent activities that may impact the engineered cover and identify when maintenance is required in order to maintain effectiveness. The MRS would require initial clearing of vegetation and large trees. Although engineered covers are technically feasible to implement, the OHARNG/Camp Ravenna would not be amenable to the level of disturbance to the environment and 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 MEC at the MRS and this process option is more susceptible to erosion and frost heave than the other containment process options. Established

vegetation and engineering controls as well as a well-planned monitoring and maintenance program may mitigate impacts to the cover. The asphalt cover alternative is not consistent with the surrounding areas at Camp Ravenna, and there are high costs associated with the implementation of an engineered cover. Although technically feasible and effective, the containment process options are not administratively feasible because they would drastically change the landscape and be unacceptable to the OHARNG/Camp Ravenna Therefore, the containment process option of natural, asphalt, and engineered covers are removed from further consideration.

3.3 Process Options Retained for the Evaluation of Remedial Alternatives

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

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FIGURE 3-3. RETAINED PROCESS OPTIONS
RVAAP-060-R-01 BLOCK D IGLOO MRS

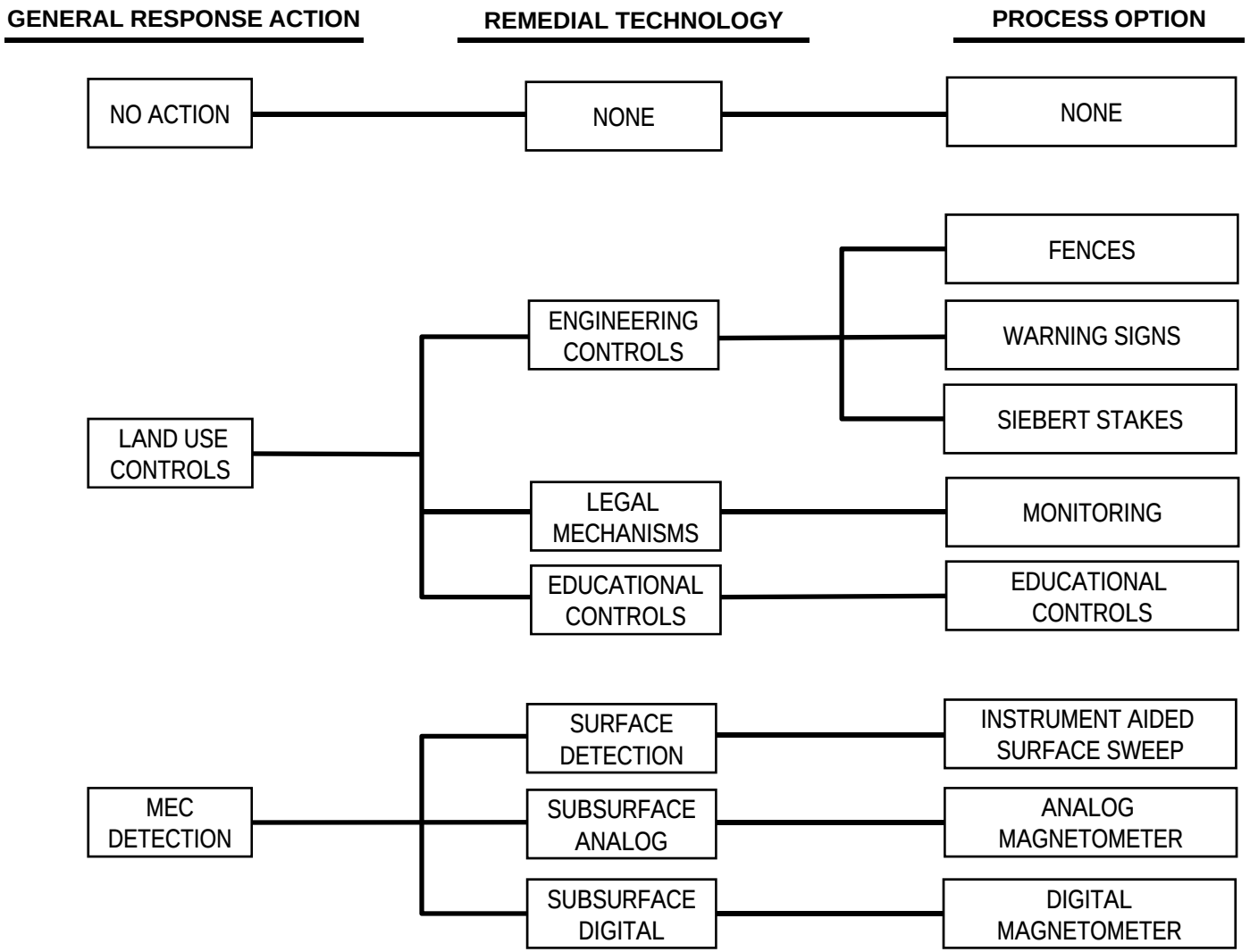

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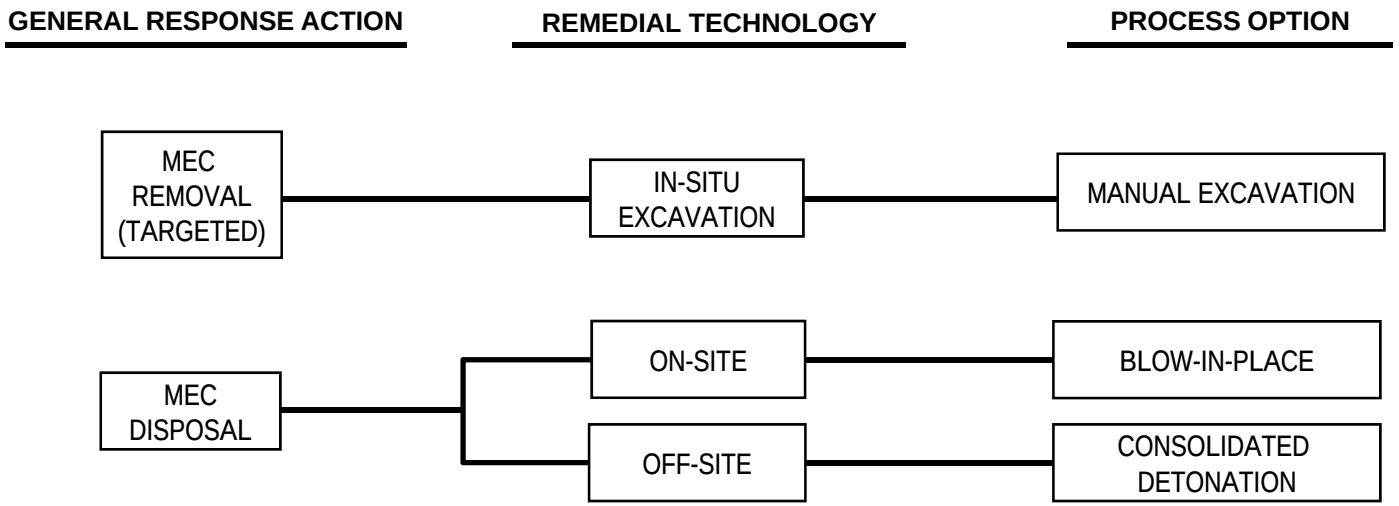
FIGURE 3-3. RETAINED PROCESS OPTIONS
RVAAP-060-R-01 BLOCK D IGLOO MRS



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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 that was completed in Section 3.0. Remedial alternatives are developed with the overall goals of protecting human health and the environment and 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 (Camp Ravenna) and disposal of hazardous substances without treatment. When hazardous substances are left on the MRS at levels that will not allow UU/UE, CERCLA Section 121(c) requires review of the protectiveness of the remedy no less than every 5 years (i.e., Five-Year Reviews).

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 is reduced through treatment, (2) the degree to which adverse effects on human health and the environment is 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§300.430(e)(7)(i); EPA, 1988).

Implementability is the ability to execute a remedial alternative at the MRS and is composed of technical and administrative feasibility. The technical feasibility of a remedial 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 a remedial 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 (40 CFR§300.430(e)(7)(ii); EPA, 1988).

Costs are composed of capital costs associated with upfront implementation, O&M costs associated with ongoing implementation and/or continued monitoring costs, and periodic costs that occur every few years. Ranges or approximations of relative capital, O&M, and periodic costs are used rather than detailed estimates. Annual costs and periodic costs are estimated over a 30-year performance period. Alternatives that provide effectiveness and implementability like those of other alternatives, but at a greater cost, can be eliminated (40 CFR§300.430(e)(7)(iii); EPA, 1988).

4.1 Development and Screening of Alternatives

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

Alternative 1—No Action

Alternative 2—LUCs

Alternative 3—Surface Removal and LUCs

Alternative 4—Surface and Subsurface Removal (UU/UE)

4.2 Screening of 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 planned MEC removal at the MRS. Rather; it would focus on restricting access and reducing human exposure to MEC through engineering controls. No military training activities would be conducted at the MRS under Alternative 2 and educational controls would be implemented to brief authorized personnel who may enter the MRS to conduct maintenance, natural resource management, or sampling activities. Site monitoring (i.e., inspections) would be conducted to ensure that the LUCs remains effective The LUCs alternative would include the engineering controls, educational controls, and monitoring that were developed through the IA (Appendix A) and as described below.

Engineering Controls would consist of an 8-foot high chain-link fence and warning signs around the perimeter of the MRS. The proposed fence would include gates at both ends of North D Road in "D" Block and Roads 1E, 2E, and 3E in "E" Block that traverse through the MRS. Fencing would be installed on both sides of Smalley Road in order to allow access through the MRS. The total length of fence would be approximately 12,500 feet. The signs warning unauthorized personnel from entering the MRS would be placed along the fence at approximate 50-foot spacing. The paths for the chain-link fence at the MRS under Alternative 2 are presented in Figure 4-1.

MEC avoidance would be implemented during fence installation activities to ensure that there are no explosive hazards at the locations where the workers are traversing and securing the fence posts in the ground. The MEC avoidance procedures would consist of a UXO-qualified person conducting an instrument-assisted surface sweep of the perimeter of the MRS where the workers will be walking, laying down materials, and installing the fence. If MEC is encountered, the UXO-qualified person will immediately stop work, document the location, and evacuate the work area.

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Source CB&I

Legend

- Location of Former Igloo 7-D-15
- Stream
- Munitions Response Site Boundary
- Jurisdictional Wetland
- Planning Level Survey Wetlands
- Chain-Link Fence

Figure 4-1
Chain Link Fence Location
Block D Igloo MRS
Camp Ravenna/Former RVAAP
Portage/Trumbull Counties, Ohio

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Any MEC found would be evaluated by the UXO-qualified personnel to determine whether it is acceptable to move for consolidated detonation or if it would require BIP. Consolidated detonation is the preferred method for MEC demolition at Camp Ravenna since the event can be managed at a controlled location at the Open Demolition Area #2 area. MEC considered acceptable to move would be transported off the MRS to temporary magazines that would be located at Open Demolition Area #2. If a MEC item is not acceptable to move then BIP is unavoidable. All notifications and procedures for consolidated detonation or BIP will be conducted in accordance with the procedures established for Camp Ravenna. This would include notifying the Ohio EPA, OHARNG/Camp Ravenna, and local emergency facilities of the proposed demolition activities, establishing a fixed demolition area, evacuating non-essential personnel to beyond the HFD for the MEC to be detonated, and conducting pre- and post-environmental sampling to ensure no MC is present. Any pits or holes created by the detonation would be backfilled and seeded with a Camp Ravenna–approved seed mix. All MD would be collected for off-site disposal at a licensed facility for flashing and recycling.

Educational Controls to be implemented would include different levels of general awareness training that would be dependent on the personnel and activities to be conducted at the MRS. Full time-employees at Camp Ravenna would receive annual general awareness training to notify them of existing conditions, existing engineering controls, MEC hazards at Camp Ravenna, and reporting procedures. The reporting procedures would stress the importance of the three "Rs"—Recognize, Retreat, and Report. Training units, visitors, and contractors that may enter the MRS would receive a general munitions awareness brief that would emphasize the aforementioned reporting procedures to the Camp Ravenna Range Control. Any MEC found at the MRS during current and future activities would be managed and destroyed in accordance with Camp Ravenna-specific procedures. Those procedures are part of the briefings currently given to all receptors and include reporting MEC to Camp Ravenna Range Control.

Monitoring (i.e. inspections) and the completion of the *Property Management Plan Inspection Form* would be conducted on an annual basis to ensure that the LUCs remain effective and protective of potential human receptors. 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 has the potential to reduce the volume of MEC through incidental destruction that may occur during MEC avoidance activities. Toxicity concerns associated with MEC would be reduced through engineering controls (i.e., fencing and signage) that would restrict access to allow for authorized personnel only as well as the destruction of incidental MEC encountered during MEC avoidance. Reporting of any MEC found by the authorized personnel that may enter the MRS and subsequent removal/demolition by UXO-qualified personnel would also reduce toxicity. The mobility of MEC at the MRS would not be reduced because MEC would remain in the top 30 inches of soil and be susceptible to freeze/thaw cycling and erosion. Once on the surface; however, the MEC is not expected to further migrate (CB&I, 2015).

No hazards are posed to the environment by the presence of MEC. Alternative 2 would be protective of human health in the long-term by eliminating the potential of MEC exposure to unauthorized personnel through engineering controls that would restrict access to the MRS. Educational controls would be effective at reducing the risk of exposure by educating the authorized personnel who may have access to the MRS about potential hazards. Monitoring (i.e., inspections) would be conducted on an annual basis to confirm that the LUCs remain effective and meet LUC objectives for continued remedy protectiveness.

Alternative 2 would present short-term risks to the on-site workers who would be installing the fence at the MRS. These risks include the potential for encountering MEC on or just below the ground

surface when traversing the MRS during installation of the chain link fence and during the intrusive activities where fence post holes would be installed. Explosive hazards associated with handling or destroying MEC represents short-term risks to the UXO-qualified personnel conducting MEC avoidance and/or the incidental destruction of MEC. Effective pre-planning and the implementation of the applicable procedures for MEC responses would be protective of the UXO-qualified personnel overseeing the installation of the engineering controls at the MRS. These procedures include Engineering Regulation (ER) 385-1-5, *Safety and Health Requirements for Operations and Activities Involving Munitions and Explosives of Concern* (USACE, 2014) and DoD 6055.09-STD, *Ammunition and Explosives Safety Standards* (DoD, 2008).

Some explosives hazards may be removed under Alternative 2 during MEC avoidance and/or the reporting and removal of any incidental MEC that may be found in the future, but LUCs would primarily be relied upon to mitigate the remaining explosive hazards at the MRS. LUCs would require continual implementation and the long-term effectiveness of this alternative cannot be guaranteed. The overall and long-term effectiveness of the LUCs would depend on the support, involvement, and willingness of the government agencies with jurisdiction to enforce and maintain the engineering controls installed to restrict access and the educational controls emplaced to modify behavior. The ARNG has authority to effectively maintain and enforce LUCs at Camp Ravenna; however, ARNG, as a national institution, has delegated that authority to the OHARNG at Camp Ravenna. LUC awareness training is already in place as an interim control for the MRS, and the OHARNG/Camp Ravenna is willing to implement and maintain engineering and educational controls and conduct site monitoring (i.e., inspections) over the long-term. Because the MRS will remain under OHARNG/Camp Ravenna control, Alternative 2 is effective in the long-term.

There are no MC concerns associated with the MRS and there are no chemical-specific ARARs. No filling or discharge to the wetland areas at the MRS would be conducted under Alternative 2, and Section 404 of the CWA is not considered to be a location-specific ARAR. No substantial surface disturbance that may contribute to erosion and sedimentation would occur under Alternative 2, and erosion and sediment control in accordance with OAC 1501:15-1-04 is not identified as an action-specific ARAR.

The timeframe of this Alternative is approximately four weeks for a fence contractor to mobilize and install the fence at the MRS. Preparation of training materials and the time required for a UXO-qualified person to travel to Camp Ravenna and conduct the initial training during the first year is also expected to take four weeks. The fence installation and preparation of training materials would be conducted concurrently. Annual training will be conducted by a UXO-qualified person through digital media (remote video training) or by in person training and includes three days. The three days covers either development of the training materials or the time to travel to Camp Ravenna to conduct in-person training. The duration for the inspections each year includes five days for a mid-level engineer or scientist and UXO escort to travel to Camp Ravenna, perform the inspection, and complete the *Property Management Plan Inspection Form*.

Implementability—The LUCs are considered technically feasible for the Block D Igloo MRS. The equipment, materials, and services required to construct a chain-link fence and install signage are readily available. Vegetation clearance would be required along the path of the fence line to access the interior heavily wooded portions of the MRS. This may result in short-term impacts to the environment and local habitats at the MRS; however, any impacts would be minimal with rapid regrowth of the vegetation. This alternative would require approval from the OHARNG/Camp Ravenna for any activities that have the potential to impact wildlife habitats. Between April 1 and

September 30, OHARNG/Camp Ravenna restricts vegetation removal since this period is considered the nesting season for ground- and forest-nesting birds, including the sharp-shinned hawk, and the roosting season for the Northern long-eared bat. Vegetation clearing activities would be conducted outside of the nesting and roosting seasons to minimize any impacts. Similar fences have been installed at Camp Ravenna to restrict access to various areas at the facility and the OHARNG/Camp Ravenna is amenable to installing a fence at the MRS if restricted access was necessary to protect receptors from potential explosive hazards. Although protection of personnel is a priority to the OHARNG/Camp Ravenna, there are potential adverse administrative concerns associated with implementing the installation of the fence and the creation of such a large restricted area at Camp Ravenna that are taken into consideration. In particular, the fence would potentially interfere with Camp Ravenna's mission as a military training facility by blocking access to areas and roadways where military training activities are routinely conducted. General awareness training and site monitoring (i.e., inspection) requirements are currently in place at other areas at Camp Ravenna in accordance with the *Draft Final Property Management Plan* (USACE, 2017) and are; therefore, considered technically and administratively feasible.

Cost—The capital costs for Alternative 2 include preparation of the *LUCs Implementation Plan* ($9,889), installation of the perimeter fence and warning signs that includes MEC avoidance and destruction of any MEC found ($453,641), preparation and shipping of training materials ($1,788), and initiation of the training activities for the MRS ($5,554) that will occur in the first year. Incorporating the LUCs into the most current version of the *Property Management Plan* is already funded and will be completed under an existing contract. Assuming administration and contingency costs at 8 percent and 30 percent, respectively, the total capital costs for this alternative are $626,025. The O&M costs consist of awareness training ($2,754 per event) and inspections in support of the *Annual Monitoring Report* that must be submitted to the Ohio EPA ($6,075 per event). The O&M costs are estimated over a 30-year performance period and the total discounted O&M costs over that time, including administration and contingency costs are $245,094. Periodic costs include the destruction of incidental MEC that may be encountered at the MRS over time. For estimating purposes; it is assumed that the destruction of incidental MEC would occur once every 5 years. The total discounted periodic costs over the 30-year performance period, including administration and contingency costs, are $27,224. The total discounted cost estimate for Alternative 2 that includes the combined capital, O&M, and periodic costs is $898,343.

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 total discounted costs of the CERCLA Five-Year Reviews, including administration and contingency costs, that are estimated over the 30-year performance period is $94,505.

Overall Evaluation—Alternative 2 would be effective at mitigating access by unauthorized receptors to the MRS where both surface and subsurface MEC would remain. Educational controls would provide the authorized personnel who may enter the MRS with the necessary information to identify and mitigate the potential for direct contact with MEC. Educational controls are already being implemented at other areas at Camp Ravenna in accordance with the *Draft Final Property Management Plan* (USACE, 2017). Monitoring (i.e., inspections) would be conducted on an annual basis to evaluate the conditions at the MRS and ensure that the LUCs are protective of potential human receptors until UU/UE is achieved. Although implementable, there are potential adverse administrative concerns that installation of a perimeter fence would potentially interfere with Camp Ravenna's mission as a military training facility by blocking access to areas and roadways where military training activities are routinely conducted. Costs associated with Alternative 2 are considered

reasonable relative to the overall effectiveness of Alternative 2. This alternative is retained for the detailed analysis of alternatives in Section 5.0.

4.2.3 Alternative 3—Surface Removal and LUCs

Alternative 3 would use instrument-aided surface sweeps to identify and remove MEC exposed at/or just below the ground surface and the sediment in the saturated and surface water areas at the MRS. Extensive subsurface excavation in surface soil and sediments would not be conducted. Surface removal would be much less expensive than a subsurface removal because little or no excavation is required. Military training consisting of foot traffic would be allowed at the MRS following completion of the response action for Alternative 3; however, surface removal of MEC alone would not attain UU/UE and there would be digging restrictions to prevent authorized personnel who may enter the MRS from encountering subsurface MEC. LUCs consisting of engineering and educational controls would be required to mitigate the potential for human exposure to remaining subsurface MEC. The engineering controls include Seibert stakes and signs to warn unauthorized receptors from entering the MRS. Educational controls include different levels of awareness training dependent on the personnel and activities to be conducted at the MRS. Site monitoring (i.e., inspections) would be conducted to ensure the effectiveness of 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.

MEC Detection would be the first step in surface MEC removal, which would be accomplished by conducting an instrument-aided surface sweep. UXO-qualified personnel would systematically walk the MRS and mark, identify, and record the locations of all MEC found on the surface for removal or subsequent demolition. The search would be conducted with a hand-held analog magnetometer such as the Schonstedt GA52-CX, or similar instrument. The operator would systematically search sweep lanes within grids using the magnetometer to identify anomalies. If the instrument indicates a response but the anomaly is not found on or just below the ground surface or sediment in shallow surface water, the UXO-qualified personnel would move on without extensive digging into the subsurface.

The MRS is 101.6 acres and is heavily forested. An instrument-aided surface sweep using a hand-held analog magnetometer can be used in areas with thick vegetation and ground cover; however, vegetation clearing would still be required in areas with thick scrub brush and along the edges of the wetlands and unnamed stream. Vegetation clearing would allow for proper operation of the detection equipment and to provide visibility for the safety of UXO-qualified personnel.

MEC Removal on the ground surface would be performed by UXO-qualified personnel intrusively investigating detected anomalies confirmed by the hand-held analog magnetometer instrument. Any MPPEH found would be verified as MDAS (i.e., MD) or MDEH (i.e., MEC) by the UXO-qualified personnel. If the MPPEH was partially exposed, or protruding above the surface, limited digging with hand tools would be conducted until the MPPEH could be verified as MD or MEC. During this time, all non-essential personnel would be evacuated beyond the HFD of 67 feet for the M-41 20-lb bomb that exploded at former Igloo 7-D-15 (DoD, 2009). It is not anticipated that removal activities under Alternative 3 would greatly disturb the environment, since only MPPEH on or just below the ground surface would be investigated.

Disturbance of fine sediments in the wetland areas would result in low visibility, and the UXO-qualified personnel would conduct an underwater tactile investigation of any target anomalies. The underwater tactile investigations would be performed by UXO-qualified personnel who are familiar with the different ordnance categories/groups and the arming and functioning of each item. After using the magnetometer to pinpoint the location of the object on the bottom of the surface water body (or in the sediment), the UXO-qualified

personnel would use their hands to gently assess the orientation of the item and, from tactile exploration, determine if it is MPPEH. If determined to be MPPEH, then the actual portion of the munitions that was found (i.e., nose, tail fin, fuze, intact bomb, etc.) would be determined by its shape. Then, using general measurement tools (i.e., elbow to wrist equals 1 foot, palm width equals 4 inches, etc.), the approximate size of the MPPEH would be determined. The MPPEH would then be evaluated if it contained a fuze (point detonating, mechanical time, proximity, etc.) and was considered to be MEC.

MEC Demolition in the terrestrial areas of the MRS would be performed on all MPPEH that is verified as MDEH (i.e., MEC). The MEC would be evaluated by the UXO-qualified personnel to determine whether it is acceptable to move for consolidated detonation or if it would require BIP. Consolidated detonation is the preferred method for MEC demolition at Camp Ravenna, since the event can be managed at a controlled location at the Open Demolition Area #2 area. MEC considered acceptable to move would be transported off the MRS to temporary magazines that would be located at Open Demolition Area #2. If a MEC item is not acceptable to move then BIP is unavoidable. All notifications and procedures for consolidated detonation or BIP will be conducted in accordance with the procedures established for Camp Ravenna. This would include notifying the Ohio EPA, OHARNG/Camp Ravenna, and local emergency facilities of the proposed demolition activities, establishing a fixed demolition area, evacuating non-essential personnel to the beyond the HFD for the MEC to be detonated, and conducting pre- and post-environmental sampling to ensure no MC is present. Any pits or holes created by the detonation would be backfilled and seeded with a Camp Ravenna–approved seed mix. All MD would be collected for off-site disposal at a licensed facility for flashing and recycling. Other debris found during the instrument-assisted visual sweep would be transported off-site for disposal or recycling as non-hazardous municipal waste.

For MEC that is found underwater, a determination would be made by UXO-qualified personnel if the item was acceptable to move. If the item was not acceptable to move, then underwater detonation would be unavoidable. Engineering controls consisting of physical barriers (i.e., sand bags) would be considered to attenuate the blast wave. Following BIP, environmental testing and restoration would be required to ensure no MC impacts to the environment.

LUCs are included in this alternative because MEC would remain in the subsurface after the surface removal. It is anticipated that the surface removal of MEC would permit the Industrial Receptor to access the MRS with no intrusive activities; however, engineering controls would be necessary to warn unauthorized personnel from entering the MRS. These engineering controls would consist of Siebert stakes and warning signs that would be placed along the perimeter of the MRS as well as along the sides of Smalley Road that travels through it. The Siebert stakes and signs would be alternately placed and would be spaced approximately 50 feet apart. The educational controls to be implemented would include different levels of awareness training that would be dependent on the personnel and activities to be conducted at the MRS. Full time-employees at Camp Ravenna would receive awareness training to notify them of existing conditions, existing engineering controls, MEC hazards at the MRS, and reporting procedures. The reporting procedures would stress the importance of the three "Rs"—Recognize, Retreat, and Report. Training units, visitors, and contractors that may enter the MRS would receive a munitions awareness brief that would emphasize the aforementioned reporting procedures to the Camp Ravenna Range Control. Any MEC found at the MRS during current and future activities would be managed and destroyed in accordance with Camp Ravenna-specific procedures. Those procedures are part of the briefings currently given to all receptors and include reporting MEC to Camp Ravenna Range Control. Inspections and completion of the *Property Management Plan Inspection Form* would be conducted on an annual basis to ensure that the LUCs remain effective and protective of potential human receptors. The paths for the Siebert stakes and sign posts at the MRS under Alternative 3 are presented in Figure 4-2.

MEC Avoidance would be implemented during installation of the Siebert stakes and warning signs to ensure that there are no explosive hazards where the workers are traversing and securing the posts in the ground. The MEC avoidance procedures would consist of a UXO-qualified person conducting an instrument-assisted surface sweep of the perimeter of the MRS where the workers will be walking, laying down materials, and installing the posts. If MEC is encountered, the UXO-qualified person would immediately stop work, document the location, and evacuate the work area. The aforementioned procedures for MEC demolition would be followed in the event that MEC was found.

Effectiveness—Alternative 3 would be effective at reducing the volume of MEC through surface removal or subsequent disposal; however, the overall degree of MEC removal would likely be minimal, since all of the MEC found during the RI was buried. The mobility of MEC at the MRS would not be reduced since residual MEC are present in the top 30 inches of soil and sediment and be susceptible to freeze/thaw cycling. Once on the surface; however, the MEC is not expected to further migrate (CB&I, 2015). The explosive hazards associated with MEC would be reduced through removal and subsequent destruction.

No hazards are posed to the environment by the presence of the MEC. Alternative 3 would be protective of human health in the long-term by removing MEC on the ground surface and the sediment. Engineering controls would clearly define the boundaries of the MRS with Siebert stakes and signage that would caution unauthorized receptors from accessing the MRS where subsurface MEC would remain. Educational controls would be effective at reducing the risk of exposure for the Industrial Receptor by providing them with the necessary information to identify and mitigate the potential for direct contact with MEC. Monitoring (i.e., inspections) would ensure that the LUCs remain effective and protective of human receptors.

Alternative 3 would present short-term risks to the on-site workers installing the Siebert stakes and signs at the MRS. These risks include the potential for encountering subsurface MEC during the intrusive activities where post would be installed. Explosive hazards associated with handling or destroying MEC represent short-term risks to the UXO-qualified personnel conducting MEC avoidance and/or the destruction of MEC. Effective pre-planning and the implementation of the applicable procedures for MEC responses would be protective of the UXO-qualified personnel conducting the work or overseeing the installation of the engineering controls at the MRS. These procedures include ER 385-1-5, *Safety and Health Requirements for Operations and Activities Involving Munitions and Explosives of Concern* (USACE, 2014) and DoD 6055.09-STD, *Ammunition and Explosives Safety Standards* (DoD, 2008).

The overall long-term effectiveness of Alternative 3 would depend on the support, involvement, and willingness of the government agencies with jurisdiction to enforce and maintain the engineering controls to limit access to the MRS and the educational controls emplaced to modify behavior. The ARNG has authority to effectively maintain and enforce LUCs at Camp Ravenna; however, ARNG, as a national institution, has delegated that authority to the OHARNG at Camp Ravenna. LUC awareness training is already in place as an interim control for the MRS, and OHARNG/Camp Ravenna is willing to maintain engineering and educational controls and conduct site monitoring (i.e., inspections) over the long term. Because the MRS will remain under OHARNG/Camp Ravenna control, Alternative 3 would be effective in the long term.

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Source CB&I

Legend

- Location of Former Igloo 7-D-15
- Stream
- Munitions Response Site Boundary
- Jurisdictional Wetland
- Planning Level Survey Wetlands
- Siebert Stake/Sign Post (50 foot spacing)

Figure 4-2
Siebert Stake and Sign Locations
Block D Igloo MRS
Camp Ravenna/Former RVAAP
Portage/Trumbull Counties, Ohio

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No chemical-specific ARARs are identified for the MRS. No filling or discharge to the wetland areas at the MRS would be conducted under Alternative 3, and Section 404 of the CWA is not considered to be a location-specific ARAR for Alternative 3. Since no substantial surface disturbance that may contribute to erosion and sedimentation would occur under Alternative 3, erosion and sediment control in accordance with OAC 1501:15-1-04 is not identified as an action-specific ARAR under Alternative 3.

The timeframe for Alternative 3 includes nine months for removal action planning documents, six months for mobilization and field activities, and six months for final reporting. Preparation of training materials and the time required for a UXO-qualified person to travel to Camp Ravenna and conduct the initial training during the first year is also expected to take four weeks. Installation of the Siebert stakes and signs following the completion of the surface removal activities would take approximately four weeks. Annual training will be conducted by a UXO-qualified person through digital media (remote video training) or by in person training and includes three days. The three days covers either development of the training materials or the time to travel to Camp Ravenna to conduct in-person training. The estimated duration for the inspections includes five days for a mid-level engineer or scientist and UXO escort to travel to Camp Ravenna, perform the inspection, and complete the Property Management Plan Inspection Form.

Implementability—The removal action defined under Alternative 3 is technically feasible. The equipment and personnel necessary to conduct the surface removal action, install Siebert stakes and signs and, conduct the training are readily available. Engineering controls consisting of Siebert stakes and signs are currently installed at other MRSs at Camp Ravenna to warn unauthorized personnel of MEC hazards. General awareness training and site monitoring (i.e., inspection) requirements are currently in place at areas at Camp Ravenna in accordance with the *Draft Final Property Management Plan* (USACE, 2017). Vegetation clearance may be required in the wetlands and unnamed stream that may result in short-term impacts to the environment and local habitats at the MRS; however, any impacts would be minimal with rapid regrowth of the vegetation. This alternative would require approval from the OHARNG/Camp Ravenna for any activities that have the potential to impact wildlife habitats. Between April 1 and September 30, OHARNG/Camp Ravenna restricts vegetation removal since this period is considered the nesting season for ground- and forest-nesting birds, including the sharp-shinned hawk, and the roosting season for the Northern long-eared bat. Vegetation clearing activities would be conducted outside of the nesting and roosting seasons to minimize any impacts.

Although UU/UE would not be obtained and subsurface MEC would remain following the implementation of Alternative 3, the MRS would be used for military training (foot traffic). Subsurface digging restrictions would be implemented to protect authorized personnel from buried MEC. The Siebert stakes and signs that would be installed would provide warning of MEC hazards to unauthorized personnel but would not physically restrict access to authorized personnel who received the proper training and instruction prior to entry. Alternative 3 is administratively feasible to the OHARNG/Camp Ravenna to implement since it is protective of both authorized and unauthorized personnel and allows use of the MRS for military training which supports Camp Ravenna's mission as a military training facility.

Cost—The capital costs for Alternative 3 include the development of the planning documents and engineering support ($108,220), preparation of the *LUCs Implementation Plan* ($9,758), field work for the surface MEC removal action ($978,099), installation of Siebert stakes and warning signs that includes MEC avoidance and destruction of MEC found ($69,657), preparation and shipping of

training materials ($1,788), and general awareness training in the first year for personnel who may enter the MRS ($5,554). Incorporating the LUCs requirements into the most current version of the *Property Management Plan* is already funded and will be completed under an existing contract. Assuming administration and contingency costs at 8 percent and 30 percent, respectively, the total capital costs for Alternative 3 are $1,642,116. The O&M costs consist of the awareness training ($2,754 per event) and site monitoring (i.e., inspections) in support of the *Annual Monitoring Report* that must be submitted to the Ohio EPA ($6,075 per event). The O&M costs are estimated over a 30-year performance period and the discounted O&M costs over that time frame, including administration and contingency costs are $245,094. Periodic costs include the destruction of incidental MEC that may be encountered at the MRS. For estimating purposes; it is assumed that the destruction of incidental MEC would occur once every 5 years. The total discounted periodic costs over the 30-year performance period, including administration and contingency costs, are $27,224. The total discounted cost estimate for Alternative 3 that includes the combined capital, O&M, and periodic costs is $1,914,434.

The costs associated with the Five-Year Reviews are not included in the total cost for Alternative 3 since they are a CERCLA requirement and are not a component of the proposed remedy. 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 $94,505.

Overall Evaluation—Alternative 3 includes the removal of MEC on the ground surface and on the sediment at the MRS that would be protective of human receptors. Engineering controls would clearly define the boundaries of the MRS with Siebert stakes and signage that would mitigate access by unauthorized receptors to the MRS where subsurface MEC would remain. Educational controls would provide the Industrial Receptor with the necessary information to identify and mitigate the potential for direct contact with MEC. Monitoring (i.e., inspections) would be conducted on an annual basis to evaluate the conditions at the MRS and ensure that the LUCs are protective of potential human receptors until UU/UE is achieved. Alternative 3 is effective, implementable, and not excessively costly relative to its overall effectiveness. Therefore, Alternative 3 is retained for detailed analysis of alternatives in Section 5.0.

4.2.4 Alternative 4—Surface and Subsurface Removal (UU/UE)

Alternative 4 would use a combination of analog and digital magnetometer instruments and manual digging to investigate and remove all surface and subsurface MEC at the MRS to the maximum exposure depth of 4 feet bgs for the Industrial Receptor. Instrument-aided surface sweeps would be conducted for sediments in the saturated and surface water areas at the MRS and would target MEC at depths where it could be investigated and removed manually. Manual digging is the preferred method of MEC removal for this alternative, since the maximum depth of MEC found during the RI was at 6 inches bgs. Successful completion of this alternative would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor at the MRS.

MEC Detection at the terrestrial areas of the MRS would be accomplished by 100-percent coverage with DGM using a portable Geometrics Model G-858G Cesium Gradiometer, or similar instrument, which is capable of detecting the MEC for the MRS between ground surface and 4 feet bgs. Use of a digital magnetometer would allow for rapid data collection with minimal personnel, resulting in a digital, georeferenced map of the entire MRS. Under Alternative 4, the data would be collected, processed, evaluated, and analyzed to select target anomalies likely to represent munitions of interest. Where an isolated target anomaly is present, the coordinates would be located again and the anomaly would be “reacquired” to

precisely pinpoint its location with a pin flag for subsequent removal. A Schonstedt GA52-CX analog magnetometer, or similar instrument, would be used in conjunction with the digital magnetometer to investigate inaccessible areas that could not be mapped due to thick ground cover or overhead canopy that limits data collection.

The instrument-aided surface sweeps for the sediments would be conducted with a hand-held analog magnetometer, such as the Schonstedt GA52-CX, Mag 1 underwater magnetometer, or similar instrument. The operator would systematically search sweep lanes within grids using the magnetometer to identify anomalies. Due to the saturated and flowing conditions of the sediments at the MRS, the maximum depth of the MEC in the sediment may be deeper than at the terrestrial portions of the MRS but is still anticipated to be relatively shallow (i.e., less than 2 feet deep) and detectable using the hand-held instruments.

The MRS is 101.6 acres and is heavily forested with thick vegetation and ground cover. Vegetation clearance would be required in areas with dense trees and brush where personnel would not be able to access with the man-portable gradiometer. The maximum diameter of any vegetation to be removed would be 3 inches and would only be removed to the extent that would allow for access and proper operation of the detection equipment. Areas of thick groundcover would be removed to provide visibility for the safety of the UXO-qualified personnel.

MEC Removal would be performed with shovels and other hand tools that minimize impact to the MRS landscape. The UXO-qualified personnel would establish 100 square foot area grids (10 feet by 10 feet) and investigate each anomaly and mark, identify, and record the locations of all MEC for removal or subsequent demolition. The conditions encountered during the RI indicated that the MPPEH was well distributed at shallow depths (i.e., less than 1 foot bgs) and there were no concentrated areas of anomalies. Each anomaly would be investigated to a maximum depth of 4 feet bgs, the maximum exposure depth for the Industrial Receptor. Any MPPEH found would be verified as MDAS (i.e., MD) or MDEH (i.e., MEC) by UXO-qualified personnel. During this time, all non-essential personnel would be evacuated beyond the HFD of 67 feet for the M-41 20 lb fragmentation bomb that exploded at former Igloo 7-D-15 (DoD, 2009). It is not anticipated that manual excavation activities would greatly disturb the environment; however, each of the excavation areas would be re-graded and seeded with a Camp Ravenna–approved seed mix to ensure regrowth.

Disturbance of the fine sediments in the wetland areas would result in low visibility, and the UXO-qualified personnel would conduct an underwater tactile investigation of any anomalies that are identified. The underwater tactile investigations would be performed by UXO-qualified personnel who are familiar with the different ordnance categories/groups and the arming and functioning of each item. After using the magnetometer to pinpoint the location of the object on the bottom of the surface water body (or in the sediment), the UXO-qualified personnel would use their hands to gently assess the orientation of the item and, from tactile exploration, determine if it is MPPEH. If determined to be MPPEH, then the actual portion of the munitions that was found (i.e., nose, tail fin, fuze, intact bomb, etc.) would be determined by its shape. Then, using general measurement tools (i.e., elbow to wrist equals 1 foot, palm width equals 4 inches, etc.), the approximate size of the MPPEH would be determined. The MPPEH would then be evaluated if it contained a fuze (point detonating, mechanical time, proximity, etc.) and was considered to be MEC.

MEC Demolition would be performed on all MPPEH that is verified as MDEH (i.e., MEC). Any MEC would be evaluated by UXO-qualified personnel to determine whether it is acceptable to move for consolidated detonation or if it requires BIP. Consolidated detonation is the preferred method for MEC demolition at Camp Ravenna, since the detonation can be managed at a controlled location at Open Demolition Area #2. MEC considered acceptable to move would be transported off the MRS to temporary magazines that would be

located at Open Demolition Area #2. If a MEC items is not considered acceptable to move then BIP would be unavoidable. All notifications and procedures for consolidated detonation or BIP will be conducted in accordance with the procedures established for Camp Ravenna. This would include notifying the Ohio EPA, OHARNG/Camp Ravenna, and local emergency agencies of the proposed demolition activities, establishing a fixed demolition area, evacuating non-essential personnel beyond the HFD for the MEC to be detonated, and conducting pre- and post-environmental sampling to ensure no MC is present. Any pits or holes created by the detonation would be backfilled and seeded with a Camp Ravenna–approved seed mix. All MD would be collected for off-site disposal for flashing and recycling. Other debris would be transported off site for disposal or recycling as non-hazardous municipal waste.

For MEC that is found underwater, a determination would be made by UXO-qualified personnel if the item was acceptable to move. If the item was not acceptable to move, then underwater detonation would be unavoidable. Engineering controls consisting of physical barriers (i.e., sand bags) would be considered to attenuate the blast wave. Following BIP, environmental testing and restoration would be required to ensure no MC impacts to the environment.

Effectiveness—Alternative 4 would be effective at reducing the toxicity, mobility, and volume of MEC at the MRS through treatment (i.e., removal) to attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor. Alternative 4 would satisfy the CERCLA preference for treatment as a principal element of an alternative. The removal of MEC to a negligible probability of exposure in soils and sediment would also be protective and provide long-term effectiveness for the Industrial Receptor. Effective pre-planning and the implementation of the applicable procedures for MEC responses are protective of the UXO-qualified personnel conducting the work at the MRS. These procedures include ER 385-1-5, *Safety and Health Requirements for Operations and Activities Involving Munitions and Explosives* of *Concern* (USACE, 2014) and DoD 6055.09-STD, *Ammunition and Explosives Safety Standards* (DoD, 2008).

No chemical-specific ARARs are identified for the MRS. The requirements of the CWA (40 CFR§230.10) is not considered to be a location-specific ARAR for the MRS since no dredging or filling activities will occur in the wetlands. Since no substantial surface disturbance that may contribute to erosion and sedimentation would occur under Alternative 4, erosion and sediment control in accordance with OAC 1501:15-1-04 is not identified as an action-specific ARAR for the MRS.

The timeliness of this Alternative is nine months for removal action planning documents, 18 months for field activities, and six months for final reporting.

Implementability—The removal of surface and subsurface MEC would be technically and administratively feasible to implement; however, the potential for impact to the environment is taken into consideration. Vegetation clearing would be necessary to remove thick ground cover and scrub brush in the wooded portions of the MRS, and removal actions would be conducted in the sediment at the saturated and surface water areas at the MRS. However, the vegetation would not be cleared to ground level, and the removal of established root systems that prevent soil and sediment erosion would not be required. The vegetation clearing may result in short-term impacts to the environment and local habitats. Between April 1 and September 30, OHARNG/Camp Ravenna restricts vegetation removal since this period is considered the nesting season for ground- and forest-nesting birds, including the sharped-shinned hawk, and the roosting season for the Northern long-eared bat. Vegetation clearing activities would be conducted outside of the nesting and roosting seasons to minimize any impacts. Any impacts would be minimal with rapid regrowth of the vegetation. Soil disturbance would be minimal, since excavation of subsurface anomalies would be conducted by

hand-digging only. The materials and services that would be required to implement the LUCs are readily available.

Cost—The capital costs for Alternative 4 include the development of the planning documents and engineering support ($108,200) and field work for the surface and subsurface MEC removal action ($4,992,675). Successful completion of Alternative 4 would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor and 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 4. The total capital costs for Alternative 4 that includes administrative and contingency costs of 8 percent and 30 percent, respectively, are $7,039,235.

Overall Evaluation—Alternative 4 includes surface and subsurface removal of MEC and removal of MEC in sediment at the saturated and surface water areas at the MRS. This alternative is a CERCLA preference since the response action would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor at the MRS. No LUCs or O&M activities would be required following the completion of Alternative 4. Therefore, Alternative 4 would be effective and implementable and is not excessively costly relative to its overall effectiveness. Therefore, Alternative 4 is retained for the detailed analysis of alternatives in Section 5.0.

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5.0 DETAILED ANALYSIS OF ALTERNATIVES

In this section, the remedial alternatives that were developed in Section 4.0 and retained for further evaluation are analyzed in detail. 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. The MEC HA in Appendix B provides useful information to supplement this detailed analysis.

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 evaluated individually so that relative strengths and weaknesses can 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 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 the 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-, action-, 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 long-term level of risk associated with MEC 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 remedial alternatives employ and the materials they will treat
- 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 on-site disposal or treatment
- 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
- Time required to achieve the 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 then 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 capacity; 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 (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% / -30%. 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 C.

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 MEC Hazard Assessment

At the conclusion of the RI, the MEC HA supports the assessment of the explosive hazards that would remain if no action were taken. This evaluation of the "No Action" alternative helps to identify the MRS conditions and land-use activities that are addressed by the removal alternatives in this FS. The MEC HA also provides an assessment of relative hazard reduction associated with remedial action alternatives (LUCs, surface, and/or subsurface cleanup, or a combination of these alternatives) through the nine CERCLA criteria analysis discussed in Section 5.1. For the CERCLA remedial action program, the information collected to apply the MEC HA, as well as its outputs, can provide useful information for several of the nine CERCLA criteria, as applicable (EPA, 2008). The MEC HA that was prepared for the Block D Igloo MRS is presented in Appendix B and includes evaluation of the alternatives retained following the development and screening of alternatives in Section 4.0. The outputs from the MEC HA are incorporated into the individual analysis of the alternatives below, where applicable.

5.3 Individual Analysis of Alternatives

The alternatives developed in Section 4.0 that were retained for detailed analysis include the following:

Alternative 1—No Action

Alternative 2—LUCs

Alternative 3—Surface Removal and LUCs

Alternative 4—Surface and Subsurface Removal (UU/UE).

The following sections provide a detailed analysis of these alternatives according to the nine NCP criteria and information provided in the MEC HA (Appendix B).

5.3.1 Alternative 1—No Action

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. The MEC HA in Appendix B further evaluates the "No Action" alternative as a baseline comparison and the efficacy of the cleanup alternatives and/or LUCs presented herein.

Overall Protection of Human Health and the Environment—The "No Action" alternative does not decrease the explosive hazards to the Industrial Receptor due to the presence of surface and subsurface MEC, since no remedial activities would be implemented at the MRS. Under the "No Action" alternative, the current activities would remain the same and the combined potential contact hours for human receptors would be

greater than 14,000 hours per year, as presented in the MEC HA. Potential hazards associated with direct contact through handle/tread underfoot and direct contact through intrusive activities is not addressed. No hazards are posed to the environment by the presence of MEC. This alternative is not protective of human health and does not meet the criterion.

Compliance with ARARs—There are no chemical-, location-, 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 explosive hazards and reduce exposure to residual MEC. No actions would be taken to reduce the magnitude of residual risks, and no institutional controls would be used to manage untreated waste. Evaluation of the "No Action" alternative in the MEC HA resulted in "moderate potential explosive hazard condition" (Hazard Level 3). The MEC HA for the No Action alternative provides a baseline of comparison for the other alternatives where LUCs and/or other remedial actions are employed.

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 MEC remaining in the surface/subsurface or sediment in the saturated or surface water areas at the Block D Igloo MRS.

Short-Term Effectiveness—Because no active remediation activities are conducted, no additional hazards above those associated with the MEC would be posed to on-site workers 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/Camp Ravenna, as no reduction in explosive hazards would occur.

Cost—The "No Action" alternative does not have any 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 potentially remaining MEC risks at the MRS. The Hazard Level for this alternative has a MEC HA score of 3, which is described as a "moderate potential explosive hazard condition". This alternative would not be protective of human health or reduce to a negligible probability the hazard of the Industrial Receptor encountering MEC in surface or subsurface soil or sediment via direct contact. As a result, Alternative 1 does not meet the RAOs.

5.3.2 Alternative 2—Land Use Controls

The LUCs alternative would reduce human exposure to MEC by restricting access, managing the activities occurring at the MRS, and performing monitoring (i.e., inspections). Engineering controls consisting of chain-link fence and warning signs would be placed around the perimeter of the MRS and along the sides of Smalley Road that traverses through the MRS. Educational controls deployed as part of this alternative would consist of training for authorized personnel who may be working at the MRS. The training would include LUC awareness, hazard recognition, and reporting procedures for any MEC found at the MRS. Monitoring (i.e., inspections) would be conducted on an annual basis to evaluate the conditions at the MRS and ensure that the LUCs are protective of potential human receptors. The MEC HA (Appendix B) further assists in evaluating the efficacy of the LUCs alternative in reducing exposure to the explosive hazards at the MRS.

Overall Protection of Human Health and the Environment—MEC would only be removed as part of MEC avoidance or destruction of MEC that is reported; therefore, the LUCs alternative would not actively treat or remove a large portion of remaining MEC at the MRS. It would be protective of human health by isolating any unauthorized personnel from exposure to the MEC through engineering controls that would restrict access to the MRS. Educational controls would be protective of human health by providing authorized personnel who may enter the MRS with information regarding the existing conditions, existing engineering controls, potential hazards, and reporting procedures for MEC that may be found. Monitoring (i.e., inspections) would be conducted on an annual basis to ensure that the LUCs remain effective and meet the RAOs for continued remedy protectiveness. No hazards are posed to the environment by the presence of MEC. This alternative provides overall protection of human health and the environment and meets the criterion.

Compliance with ARARs— There is no MC identified for the MRS, and chemical-specific ARARs do not apply. No filling or discharge to the wetland areas at the MRS would be conducted under Alternative 2, and Section 404 of the CWA is not considered to be a location-specific ARAR. No substantial surface disturbance that may contribute to erosion and sedimentation would occur under Alternative 2, and erosion and sediment control in accordance with OAC 1501:15-1-04 is not identified as an action-specific ARAR.

Long-Term Effectiveness and Permanence—The LUCs alternative does not involve active treatment or removal of MEC from the MRS. The potential exists for the removal of MEC if found during MEC avoidance in support of installation of engineering controls or reported MEC that is removed during future activities. Any MEC found would be destroyed by UXO-qualified personnel in accordance with Camp Ravenna procedures, and MPPEH that is verified as MDAS (i.e., MD) would be transported to a licensed facility for flashing and recycling. The willingness of the OHARNG/Camp Ravenna to respond to and remove MEC finds at Camp Ravenna has been historically effective and reliable and is expected to remain so in the future. In the absence of an active removal process, MEC would remain in place at the MRS above levels that attain UU/UE or unrestricted access for the Industrial Receptor. The LUCs would reduce the magnitude of residual hazards to unauthorized receptors by mitigating exposure to the MEC by installing engineering controls (i.e., chain-link fencing and warning signs) that restrict or discourage access to the MRS. The installation of fencing and warning signs is common at Camp Ravenna. Awareness training is already being implemented at Camp Ravenna and has been effective and reliable and is expected to remain so in the future. Monitoring (i.e., inspections) would be conducted on an annual basis to ensure the LUCs remain effective and still meet the LUC objectives for continued remedy protectiveness in the long-term. Evaluation of the LUCs alternative in the MEC HA resulted in a “moderate potential explosive hazard condition” (Hazard Level 3). The LUCs would require continual implementation to ensure long-term effectiveness. The ARNG has the financial capability, and both the ARNG and OHARNG/Camp Ravenna are willing to implement LUCs. Therefore, the LUCs would be adequate and reliable controls in the management of residual hazards associated with the MRS,

and long-term effectiveness would be ensured. Because MEC would remain in place at the MRS above levels that attains UU/UE, Five-Year Reviews would be necessary until UU/UE is attained to verify this alternative remains effective.

Reduction of Toxicity, Mobility, or Volume Through Treatment—With the exception for removal or destruction of incidental MEC, this alternative would not involve deliberate treatment, removal, or disposal of MEC at the MRS. Toxicity concerns associated with MEC would be reduced at the MRS through engineering controls that would restrict access to unauthorized personnel, awareness training of the MEC hazards at the MRS for authorized personnel, and the removal of any MEC reported to the Camp Ravenna Range Control. Any MEC found would be removed and/or destroyed by UXO-qualified personnel that would result in a minor reduction in the volume (number) and overall hazards associated with MEC, but would not satisfy the statutory preference for employing treatment as a principle element. Alternative 2 would not address the mobility of MEC.

Short-Term Effectiveness— Under Alternative 2, no removal actions would be conducted; however, there would be short-term risks for workers installing the chain-link fence at the MRS and for UXO personnel conducting MEC avoidance and the removal of incidental MEC. The implementation of the LUCs reduces the risk of human exposure to MEC in the short term by restricting access for unauthorized receptors and providing the authorized receptors that may access the MRS with the necessary information to identify and mitigate the potential for direct contact with MEC. UXO-qualified personnel that would respond to and remove any MEC found are required to have specialized training that would mitigate the short-term explosive hazards to which they would be exposed. The only physical activities that will occur at the MRS include construction of the perimeter fence and the environment would not face additional adverse impacts due to construction activities, such as erosion, sedimentation, or significant vegetative damage. This alternative's remedial measures would require less than 1 year to complete, but would require long-term O&M (30 years assumed for cost estimating purposes) of the engineering controls (i.e., chain-link fence and warning signs) and implementation of the educational controls at the necessary frequency.

Implementability—This alternative would not interfere with any planned remedial action at the MRS in the future. Preparing an appendix to the most current version of the *Property Management Plan* and implementing the LUCs (chain-link fence and warning signs, awareness training, and inspections) would be technically feasible to implement. OHARNG/Camp Ravenna is amenable to installing a fence at the MRS if restricted access was necessary to protect receptors from potential explosive hazards but there are potential adverse administrative concerns associated with implementing the installation of the fence and creation of such a large restricted area at Camp Ravenna that are taken into consideration. In particular, the installation of a fence would potentially interfere with Camp Ravenna's mission as a military training facility by blocking access to areas and roadways where military training activities are routinely conducted. Consultation and approval of this remedy by the Ohio EPA as the final remedy would be required.

Cost—The capital costs associated with Alternative 2 are $626,025. The capital costs would occur in the first year of the response action and include preparation and implementation of the *LUC Implementation Plan*, installation of the fence and warning signs around the perimeter of the MRS that includes MEC avoidance and destruction of MEC found, and the initial general awareness training event that would then occur on an annual basis or when workers are required to enter the MRS. The discounted O&M cost for Alternative 2 is $245,094 and includes the annual awareness training and inspections for the MRS. The O&M costs are estimated over a 30-year performance period. Periodic costs include the destruction of incidental MEC that may be encountered over the 30-year performance period. For estimating purposes, it is assumed that the destruction of incidental MEC would occur once every 5 years. The discounted periodic costs for Alternative

2 are $27,224. The total discounted cost estimate for Alternative 2 that includes the capital, O&M, and periodic costs is $898,343. This estimate includes administrative and contingency costs of 8 percent and 30 percent, respectively. 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 $94,505. The detailed breakdown of the costs for Alternative 2 is provided in Appendix C.

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 would take action to mitigate potentially remaining MEC risks at the MRS through engineering controls that would restrict access to unauthorized receptors and educational controls that would inform authorized receptors about the existing conditions, existing engineering controls, potential hazards, and reporting procedures for MEC that may be found. Monitoring (i.e., inspections) would be conducted on an annual basis to evaluate the conditions at the MRS and ensure that the LUCs remain effective and still meet LUC objectives for continued remedy protectiveness. This alternative is technically implementable and protective of human health. Although administratively feasible to implement, there are concerns that installation of a perimeter fence would potentially interfere with Camp Ravenna's mission as a military training facility by blocking access to areas and roadways where military training activities are routinely conducted. No hazards are posed to the environment by the presence of MEC. Alternative 2 has a MEC HA score of 3, which is described as a "moderate potential explosive hazard condition"; however, the LUCs would reduce the unacceptable hazard at the MRS such that the likelihood of any receptors encountering MEC via direct contact is negligible. As a result, Alternative 2 meets the RAOs.

5.3.3 Alternative 3—Surface Removal and LUCs

Alternative 3 would use instrument-aided surface sweeps to remove all MEC on or just below the ground surface and sediment in the saturated and surface water areas at the MRS. Implementation of this alternative would not attain UU/UE since subsurface MEC would remain; however, it would be sufficient to permit the Industrial Receptor to access the MRS for military training. For this use, only foot traffic would be allowed for authorized personnel and digging restrictions would be in effect. LUCs consisting of engineering and educational controls and site monitoring (i.e., inspections) would be required to protect the Industrial Receptor from the subsurface MEC. The engineering controls would consist of Siebert stakes and warning signs that would be placed along the perimeter of the MRS at 50-foot intervals as well as along the sides of Smalley Road that travels through it. Educational controls would include different levels of awareness training that would be dependent on the personnel and activities to be conducted at the MRS. Site monitoring (i.e., inspections) would be conducted to ensure the effectiveness of the LUCs. The MEC HA (Appendix B) further assists in evaluating the efficacy of Alternative 3 in reducing exposure to the explosive hazards at the MRS. Five-Year Reviews would be necessary until UU/UE is attained to verify this alternative remains effective.

Overall Protection of Human Health and the Environment—Alternative 3 would involve the active removal of MEC on or just below the ground surface and sediment in the saturated and surface water areas at the MRS. The Industrial Receptor would be protected from potential exposure to the subsurface MEC through a combination of engineering and educational controls. Evaluation of surface removal in the MEC HA resulted

in a "low potential explosive hazard condition" (Hazard Level 4) due to the residual subsurface MEC. The engineering controls consisting of Siebert stakes and warning signs would be protective of unauthorized receptors by alerting them to the MRS boundary. The educational controls (i.e., awareness training, hazard recognition, and response) would be protective of human health by providing authorized personnel who may enter the MRS with information necessary recognize and avoid the hazards at the MRS. Monitoring (i.e., inspections) would be conducted on an annual basis to ensure that the LUCs remain effective and still meet LUC objectives for continued remedy protectiveness. No hazards are posed to the environment by the presence of MEC. Overall, the risk to human receptors is reduced through the implementation of surface removal of MEC and the LUCs that include engineering and educational controls and monitoring. Alternative 3 is protective of human health and the environment and meets this criterion.

Compliance with ARARs—There is no MC identified for the MRS, and chemical-specific ARARs do not apply. Sensitive areas at the MRS include wetlands and an unnamed stream that would be accessed for the evaluation and possible removal of MEC. Due to the shallow nature of the saturated and surface water areas at the MRS, no filling would be necessary to access the wetlands and no dredging activities would be conducted to remove any residual MEC; therefore, Section 404 of the CWA is not a location-specific ARAR for this alternative. The State of Ohio erosion and sediment control regulations are potentially relevant and appropriate only if MEC removal activities disturb the land surface enough to contribute to erosion and sedimentation. Large-scale excavations are not anticipated, and only surface soil to a shallow depth would be disturbed as part of the surface removal activities; therefore, the State of Ohio erosion and sediment control regulations are not an action-specific ARAR for this alternative. Alternative 3 meets this threshold criterion.

Long-Term Effectiveness and Permanence—This alternative would involve the active removal of MEC on or just below the ground surface and on the sediment at the shallow surface water areas at the MRS. Subsurface MEC would only be removed as part of MEC avoidance activities in support of the installation of the posts for the Siebert stake and signs. The activities to be completed under Alternative 3 would allow for authorized personnel to enter the MRS for military training (foot traffic); however, there would be digging restrictions to prevent the authorized personnel from encountering subsurface MEC. The engineering controls consisting of Siebert stakes and warning signs would reduce the magnitude of residual hazards at the MRS to unauthorized receptors by alerting them of the MRS boundaries. The educational controls would reduce the magnitude of residual hazards by mitigating exposure to subsurface MEC by providing the Industrial Receptor with the information necessary to recognize and avoid the hazards at the MRS. Awareness training is already being implemented at Camp Ravenna and has been effective and reliable and is expected to remain so in the future. Monitoring (i.e., inspections) would be conducted on an annual basis to ensure the LUCs remain effective and still meet the RAOs for continued remedy protectiveness in the long-term. Evaluation of surface removal in the MEC HA resulted in a "low potential explosive hazard condition" (Hazard Level 4) based on the MEC that would remain, but the LUCs would require continual implementation to ensure long-term effectiveness. Five-Year Reviews would be necessary until UU/UE is achieved to verify this alternative remains effective.

Reduction of Toxicity, Mobility, or Volume Through Treatment—Alternative 3 would be effective at reducing the volume by treatment (i.e., removal) of MEC on or just below the ground surface and sediment in the shallow surface water areas at the MRS; however, the overall degree of MEC removal would likely be minimal, since all of the MEC that was found during the RI was buried. The mobility of MEC at the MRS would not be reduced, since it would potentially remain in the top 30 inches of soil and sediment and would be susceptible to freeze/thaw cycling. Any MEC that becomes exposed is not expected to mobilize further. The explosive hazards associated with potentially harmful MEC on the ground surface or the sediment at the

MRS would be reduced by the removal action; however, explosive hazards would persist for any remaining MEC in the subsurface or buried in the sediment. Overall, this alternative would result in a reduction in the volume (number) and overall hazards associated with MEC. This is supported by the MEC HA Hazard Level of 4, "low potential explosive hazard condition" for this alternative. Alternative 3 includes the intentional removal and/or treatment of MEC potentially present on the surface of the MRS. Because the majority of the MEC on the MRS is present in the subsurface, Alternative 3 relies primarily on LUCs to be protective in the long-term. Therefore, Alternative 3 does not satisfy the statutory preference for employing treatment to permanently and significantly reduce the toxicity, mobility, or volume of MEC as a principal element.

Short-Term Effectiveness—Removal of the MEC on or just below the ground surface and sediment in the saturated and surface water areas at the MRS under Alternative 3 would present short-term hazards to UXO-qualified personnel through handling, removal, and demolition operations. There are also short-term explosive hazards for workers who would be installing the Siebert stakes and signs along the perimeter of the MRS as part of the engineering controls. The UXO-qualified personnel would conduct MEC avoidance activities in support the installation activities. UXO-qualified personnel are required to have specialized training that would mitigate the short-term explosive hazards for them and onsite workers during the response action. Manual excavation in the saturated and surface water areas present the greatest short-term risk to UXO-qualified personnel since visibility is low and would limit them from being able to visually verify the anomaly. Conducting a tactile underwater investigation would be protective of the UXO-qualified personnel, since it follows a proven verification process to aid in determining the type and condition of MEC that is found prior to jarring or moving. The potential short-term effects to non-UXO–qualified personnel could be further mitigated by establishing an Exclusion Zone that ensures they maintain a safe distance (i.e., the HFD) from an anomaly when it is being investigated. Vegetation clearing at the terrestrial and surface water areas at the MRS would have potential short-term impacts on the environment due to the disturbance of wildlife and nesting habitats. Between April 1 and September 30, OHARNG/Camp Ravenna restricts vegetation removal since this period is considered the nesting season for ground- and forest-nesting birds, including the sharped-shinned hawk, and the roosting season for the Northern long-eared bat. Vegetation clearing activities would be conducted outside of the nesting and roosting seasons to minimize any impacts. Soil disturbance would be minimal, since large-scale excavation is not anticipated and excavation of subsurface anomalies would be conducted by hand-digging only. Site restoration using a Camp Ravenna-approved seed mix would be conducted at exposed or disturbed soil areas. The materials and services that would be required to implement Alternative 3 are readily available.

Following the surface removal action, short-term hazards posed to the Industrial Receptor at the MRS would be direct contact with residual MEC that may become exposed on the ground surface via freeze/thaw cycling. The implementation of the LUCs 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 MEC. UXO-qualified personnel that would respond to and remove any MEC found following the completion of the remedial actions under Alternative 3 are required to have specialized training that would mitigate the short-term explosive hazards for these responders. The alternative's remedial measures would require 1 to 2 years to complete and would require O&M in the form of annual implementation of the LUCs (30 years assumed for cost estimating purposes).

Implementability—Alternative 3 would be technically feasible to implement. Standard hand-held magnetometers (i.e., Schonstedt GA52-CX, or similar instrument) can easily be obtained to conduct the instrument-aided surface sweeps. UXO-qualified personnel who are specially trained for EOD work and who would conduct the sweeps and MEC removal are readily available. Alternative 3 would require vegetation to be removed at the MRS for proper operation of the detection equipment and to provide visibility for the safety

of UXO-qualified personnel. Camp Ravenna vegetation removal restrictions that are protective of the possible nesting and roosting habitats at the MRS would be followed by not clearing vegetation/trees during the April 1 to September 30 time frame. The LUCs to be implemented following the remedial action would be easily implemented. No technical difficulties are anticipated in installing the Siebert stakes and warning signs or establishing or maintaining the training programs; however, MEC avoidance would be necessary to ensure there are no explosive hazards where the workers are traversing or installing the posts. Careful planning would be required with the OHARNG/Camp Ravenna to minimize disruptions and/or impacts to Camp Ravenna operations at surrounding properties during implementation of the remedial action. The services and materials required to implement Alternative 3 are readily available. Alternative 3 would be administratively feasible to the OHARNG/Camp Ravenna to implement since it is protective of both authorized and unauthorized personnel and allows use of the MRS for military training which supports Camp Ravenna's mission as a military training facility. Revising Appendix A of the most current version of the *Property Management Plan* and implementing the LUCs (Siebert stakes, warning signs, awareness training, and site monitoring) are technically implementable and administratively feasible. Consultation and approval of this remedy by the Ohio EPA as the final remedy would be required.

Cost—The capital costs associated with implementation for Alternative 3 are $1,642,116. The capital costs would occur in the first year of the response action and include mobilization/demobilization, vegetation removal, instrument-assisted visual survey, MEC surface removal, off-site disposal of MDAS, site restoration, installation of Siebert stakes and signs around the perimeter of the MRS that includes MEC avoidance and destruction of MEC found, initiation of LUCs awareness training, monitoring (i.e., inspections), and reporting, and destruction of MEC that may be encountered during the surface removal field work. The discounted O&M cost for Alternative 3 is $245,094, which includes the annual LUCs training for the MRS. The O&M costs are estimated over the 30-year performance period. Periodic costs include the destruction of incidental MEC that may be encountered over the 30-year performance period. For estimating purposes; it is assumed that the destruction of incidental MEC would occur once every 5 years. The discounted periodic costs are $27,224. The total discounted cost estimate for Alternative 2 that includes the capital, O&M, and periodic costs is $1,914,434. This estimate includes administrative and contingency costs at 8 percent and 30 percent, respectively. 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 $94,505. The detailed breakdown of the costs for Alternative 3 is provided in Appendix C.

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 would take action to mitigate the risks of potential exposures to explosive hazards at the MRS through the removal of surface MEC and the implementation of educational controls to restrict direct contact of the Industrial Receptor with the residual MEC. Engineering controls consisting of Seibert stakes and warning signs would caution unauthorized personnel from entering the MRS. The educational controls (i.e., awareness training, hazard recognition, and response) would be protective of human health by providing authorized personnel who may enter the MRS with information necessary recognize and avoid the hazards at the MRS. Monitoring (i.e., inspections) would be conducted on an annual basis to evaluate the conditions at the MRS and ensure that the LUCs remain effective and still meet LUC objectives for continued remedy protectiveness. The Alternative 3 MEC HA Hazard Level is 4, "low potential

explosive hazard condition" and supports the assertion that treatment reduces the inherent hazards posed by the principal threats at the MRS. This alternative would be technically implementable, administratively feasible, and protective of human health. There are no ARARs for Alternative 3. No hazards would be posed to the environment by the presence of remaining subsurface MEC. Alternative 3 would reduce the unacceptable hazard from MEC on the ground surface at the MRS such that the likelihood of the Industrial Receptor encountering MEC via direct contact is negligible. As a result, Alternative 3 meets the RAOs.

5.3.4 Alternative 4—Surface and Subsurface Removal (UU/UE)

Alternative 4 would include the systematic search and complete removal of surface and subsurface MEC utilizing full-coverage DGM and manual excavation of target anomalies. Any MEC in sediment would be removed to the deepest extent possible that can be accessed via manual digging methods. Successful completion of this alternative would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor at the MRS.

Overall Protection of Human Health and the Environment—Alternative 4 would involve the active removal of all MEC and no hazards would remain at the MRS following the completion of the response action. Alternative 4 would attain UU/UE and would also be protective of the Industrial Receptor that has a maximum exposure depth of 4 feet bgs. This alternative is protective of human health and the environment and meets the criterion.

Compliance with ARARs—The only potential location-specific ARAR identified for the MRS under Alternative 4 is 40 CFR§230.10 for activities that may disturb the wetlands. Because no dredging or filling activities will occur in the wetlands, the requirements of 40 CFR§230.10 are not triggered.

Long-Term Effectiveness and Permanence—Alternative 4 would achieve long-term effectiveness and permanence at the MRS through active removal of all surface/subsurface MEC. The maximum anticipated depth of MEC is less than 1 foot bgs which is less than the maximum exposure depth of 4 feet bgs for the Industrial Receptor. The successful completion of Alternative 4 would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor at the MRS. Alternative 4 would result in complete removal of MEC at the MRS for the Industrial Receptor exposure scenario, and no residual hazards would remain. The magnitude of the hazards would be eliminated, and no residual or untreated wastes would remain. Since UU/UE will be attained, Five-Year Reviews would not be necessary. Evaluation of Alternative 4 in the MEC HA resulted in a Hazard Level of 4, "low potential explosive hazard condition".

Reduction of Toxicity, Mobility, or Volume Through Treatment—Alternative 4 would result in the complete removal of all MEC at the MRS that allows for UU/UE. The maximum depth of MEC at the MRS is less than 1 foot bgs and the complete removal of MEC attains UU/UE and a negligible probability of exposure for the Industrial Receptor. The explosive hazard (toxicity) associated with MEC would be completely removed from the MRS. Alternative 4 includes the intentional removal and/or treatment of MEC, thus satisfying the statutory preference for employing treatment as a principle element.

Short-Term Effectiveness—The removal of surface and subsurface MEC and MEC in sediment under Alternative 4 would present a hazard to UXO-qualified personnel through handling, removal, and demolition operations. UXO-qualified personnel are required to have specialized training that would mitigate the short-term explosive hazards for them during the remedial action. Manual excavation in the saturated and surface water areas present the greatest short-term risk to UXO-qualified personnel, since visibility is low and would limit them from being able to visually verify the anomaly. Conducting a tactile underwater investigation would

be protective of UXO-qualified personnel, since it follows a proven verification process to aid in determining the type and condition of MEC that is found prior to jarring or moving. The potential short-term effects to non-UXO–qualified personnel could be further mitigated by establishing an Exclusion Zone that ensures they maintain a safe distance (i.e., the HFD) from an anomaly when it is being investigated. The extent of vegetation clearing required at the terrestrial and surface water areas at the MRS under this alternative would have potential short-term impacts on the environment due to the disturbance of wildlife habitats. Between April 1 and September 30, OHARNG/Camp Ravenna restricts vegetation removal since this period is considered the nesting season for ground- and forest-nesting birds, including the sharped-shinned hawk, and the roosting season for the Northern long-eared bat. Vegetation clearing activities would be conducted outside of the nesting and roosting seasons to minimize any impacts. Soil disturbance would be minimal, since large-scale excavation is not anticipated and excavation of subsurface anomalies would be conducted by hand-digging only. Although the maximum exposure depth for the Industrial Receptor if 4 feet bgs, the actual soil disturbance would be expected to be minimal since the maximum depth of anticipated MEC is less than1 foot bgs. The alternative's remedial measures would require 2 to 3 years to complete with no requirements for O&M.

Implementability—Alternative 4 is technically and administratively feasible to implement. Standard digital magnetometer instruments (i.e., Geometrics Model G-858G Cesium Gradiometer, or similar instrument) can easily be obtained to conduct the DGM. Standard hand-held analog magnetometers (i.e., Schonstedt GA52-CX and Mag 1 underwater magnetometer) can easily be obtained to support the DGM work and conduct the sediment surveys. UXO-qualified personnel who are specially trained for EOD work and who would support the DGM and conduct any MEC removal are readily available. Camp Ravenna vegetation removal restrictions that are protective of the possible nesting and roosting habitats at the MRS would be followed by not clearing vegetation/trees during the April 1 to September 30 time frame. The services and materials required to implement Alternative 4 are readily available.

Cost—The capital costs associated with up front implementation for Alternative 4, including administrative and contingency costs of 8 and 30 percent, respectively, are $7,039,235. The capital costs occur in the first year and include mobilization/demobilization, vegetation removal, DGM field work, anomaly reacquisition, MEC removal, off-site disposal of MDAS, destruction of MEC, and site restoration. This alternative attains UU/UE as well as a negligible probability of exposure for the Industrial Receptor; therefore, there are no O&M, periodic, or Five-Year Review costs for this alternative. The detailed breakdown of the costs for Alternative 4 is provided in Appendix C.

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 4 takes action to remove any remaining explosive hazards at the MRS through surface and subsurface removal MEC and MEC in sediment in saturated and surface water areas. Alternative 4 would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor. This alternative would employ treatment as a principle element which is a CERCLA preference. The MEC HA Hazard Level of 4 for this alternative represents a "low potential explosive hazard condition". This alternative would be technically implementable, administratively feasible, and protective of human health and the environment. As a result, Alternative 4 meets the RAOs.

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 between 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—No hazards are posed to the environment by the presence of MEC. Alternative 1 would take no action and would not be protective of human health. Thus Alternative 1 does not meet this criterion. Alternatives 2 through 4 are protective of human health. These alternatives restrict or eliminate exposure to MEC at the MRS through MEC removal and/or LUCs. Both Alternatives 2 and 3 are protective through LUCs by restricting direct contact of receptors to MEC through engineering and educational controls and monitoring (i.e., inspections). Alternative 3 would remove MEC on or just below the ground surface and sediment that would allow for the Industrial Receptor to use the MRS for military training (foot traffic) with no intrusive activities. Alternative 4 would ensure that surface and subsurface MEC and MEC in sediment are removed to a maximum exposure depth of 4 feet bgs, which attains UU/UE as well as a negligible probability of exposure for the Industrial Receptor. Alternatives 2, 3, and 4 meet this criterion.

Compliance with ARARs— No chemical-specific ARARs were identified for the MRS. No action-or location-specific ARARs are triggered under Alternative 1 because no actions will be taken. Because no dredging or filling activities will occur in the wetlands as part of Alternatives 2, 3, and 4, the requirements of 40 CFR§230.10 are not triggered. The maximum diameter of any vegetation removed under Alternatives 2, 3, and 4 would be 3 inches. Vegetation would only be removed, as necessary, to allow for personnel access, proper operation of the MEC detection equipment, and installation of engineering controls (i.e., chain-link fence or Siebert stakes and signs). The target anomalies that would be identified for both Alternatives 3 and 4 would be easily reacquired using manual excavation. Therefore, large-scale vegetation clearing and excavation that may contribute to erosion and sedimentation is not anticipated. As a result, OAC 1501.15-1-04 erosion and sediment control requirements are not triggered under Alternatives 2, 3, and 4.

Long-Term Effectiveness and Permanence—No actions would be taken under Alternative 1 to address the explosive hazards associated with residual surface and subsurface MEC on the MRS. Alternative 1; therefore, would not provide long-term effectiveness and permanence. There are different degrees of long-term effectiveness and permanence associated with Alternatives 2 through 4. Because Alternative 2 would rely on LUCs with incidental MEC removal, its effectiveness and permanence would depend on maintaining the controls emplaced to restrict access, modify behavior, and conduct monitoring (i.e., inspections) to ensure the LUCs remain effective and still meet the LUC objectives for continued remedy protectiveness. Similar chain-link fences have been installed at Camp Ravenna to restrict access to various areas at the installation, awareness training is already in place as an interim control for the MRS, and the OHARNG/Camp Ravenna is willing to maintain educational controls and conduct monitoring (i.e., inspections) over the long term. Because the MRS will remain under OHARNG/Camp Ravenna control, Alternative 2 is effective in the long term and permanent. However, fewer MEC would be permanently removed under Alternative 2 in comparison to Alternatives 3 and 4. Under Alternative 2, MEC would only be removed as part of MEC avoidance during installation of the engineering controls and any subsequent MEC that may be reported during future activities.

Alternative 3 would have greater effectiveness and permanence than Alternatives 1 and 2, since it would involve the removal of MEC on the ground surface and sediment in the shallow surface water areas. MEC avoidance under Alternative 3 would potentially remove subsurface MEC that is found at locations where the Siebert stakes and signs posts are installed. Alternatives 3 and 4 would involve the systematic search and removal of MEC, albeit to different degrees of removal. Alternative 3 would not be as effective as Alternative 4, which would include removal of surface and subsurface MEC and MEC in sediment that would result in UU/UE. The magnitude of the hazards would be eliminated under Alternative 4, and no residuals or untreated waste that would represent the potential for exposure to the Industrial Receptor would remain. As a result, Alternative 4 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 any reduction of the toxicity, mobility, or volume of MEC. Alternative 1 does not satisfy the statutory preference for employing treatment as a principal element. Alternative 2 provides no treatment or removal of MEC, other than MEC avoidance during the installation of the chain-link fence and the removal of any incidental MEC that is reported during future activities. Therefore, Alternative 2 does not satisfy the statutory preference for employing treatment as a principal element. Alternative 3 provides a reduction in the volume of MEC on or just below the ground surface and sediment; however, MEC would remain in the subsurface. Although removal of MEC on or just below the ground surface and sediment would result in a "low potential explosive hazard condition" based on the MEC HA, it would not reduce the potential mobility of subsurface MEC to the surface. The maximum depth of MEC found at the MRS during the RI is less than 1 foot bgs and is susceptible to freeze/thaw cycling that can occur up to depths of 30 inches bgs in northeast Ohio. Alternative 3 would not reduce the inherent risks posed by remaining MEC in the subsurface and relies primarily on LUCs to be protective over the long-term. As a result, Alternative 3 does not satisfy the statutory preference for employing treatment as a principle element. Alternative 4 includes the complete removal of surface/subsurface MEC and MEC in the sediment and satisfies the statutory preference for employing treatment as a principal element.

Short-Term Effectiveness—Alternative 1 would take no action and the explosive hazard posed by the MEC would be unaltered in the short-term; therefore, there would be no adverse short-term effects. Under Alternative 2, no removal actions would be conducted; however, there would be short-term risks above the baseline conditions for workers installing the chain-link fence at the MRS and for UXO personnel conducting MEC avoidance and the incidental destruction of any MEC found during future activities. The LUCs to be implemented under Alternative 2 could be quickly established and would further reduce short-term risks by mitigating the potential for exposure to MEC at the MRS through engineering and educational controls and monitoring (i.e., inspections). The short-term effectiveness of Alternative 2 is considered to be moderate in comparison to the alternatives that involve the search and physical removal of MEC. The short-term effectiveness of Alternatives 3 and 4 would be affected by the handling, removal, and demolition operations of MEC by UXO-qualified personnel. The short-term risks to UXO-qualified personnel under Alternative 4 would be greater than for Alternative 3, since Alternative 4 would include the removal of surface and subsurface MEC that is more time-consuming and complex versus Alternative 3 that would include surface MEC removal only. The only subsurface removal of MEC under Alternative 3 would be during MEC avoidance as part of the installation of the Siebert stakes and signs as engineering controls around the perimeter and along roadways at the MRS. UXO-qualified personnel are required to have specialized training that would mitigate the short-term explosive hazards for them and the onsite workers during the remedial action. The vegetation clearing required at the MRS under Alternatives 2, 3, and 4 would potentially adversely impact the environment in the short-term by disturbing wildlife habitat that is used by ground- and forest-nesting birds, including the sharp-shinned hawk, and by the Northern long-eared bat for roosting. Camp Ravenna

vegetation removal restrictions that are protective of these habitats would be followed by not clearing vegetation/trees during the April 1 to September 30 time frame. The only vegetation clearance and soil disturbance required under Alternative 2 would be for installation of the chain-link fence. Soil and sediment disturbance for both Alternatives 3 and 4 would be minimal, since MEC removal would be conducted by manual excavation (i.e., hand digging and underwater tactile investigations) only. The short-term exposure under Alternative 3 would also be less than for Alternative 4, since a shorter time frame would be required to complete Alternative 3. Summarily, the short-term effectiveness of Alternatives 3 and 4 are considered to be low in comparison to Alternatives 1 and 2, but are considered acceptable due to the measures that will be taken to mitigate the risks.

Implementability—Although easy to technically implement, Alternative 1 is the least administratively feasible to implement because the stakeholders are not likely to accept "No Action" as a remedy. Alternatives 2 is technically feasible to implement since there no specialized equipment is required to install the perimeter fence and awareness training and monitoring is already being conducted at Camp Ravenna. Alternative 2 is administratively feasible to implement; however, there are adverse administrative concerns that installation of a perimeter fence would interfere with Camp Ravenna's mission as a military training facility by blocking access to areas and roadways where military training activities are routinely conducted. Alternatives 3 and 4 are technically feasible to implement since the equipment and personnel required to conduct the response actions are readily available. Alternative 3 is administratively feasible to implement since it is protective of both authorized and unauthorized personnel and allows use of the MRS for military training (i.e., foot traffic with no intrusive activities) which supports Camp Ravenna's mission. Alternative 4 is administratively feasible to implement since it attains UU/UE as well as a negligible probability of exposure for the Industrial Receptor. Overall, the degree of implementability for Alternatives 3 and 4 that involve the actual removal of MEC would be more complex than Alternatives 1 and 2 that do not include any planned MEC removal actions. Alternative 4 would be the most difficult alternative to implement since it would remove both surface and subsurface MEC.

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

Alternative 1, No Action—$0

Alternative 2, LUCs—$898,343

Alternative 3, Surface Removal and LUCs—$1,914,434

Alternative 4, Surface and Subsurface Removal (UU/UE)—$7,039,235

Since no action would be implemented under Alternative 1, there are no costs associated with this alternative. Alternative 2 has the lowest total costs in comparison to Alternatives 3 and 4 but the costs for Alternative 2 include O&M and periodic costs. Alternative 3 has lower total costs than Alternative 4 but similar to Alternative 2, there are O&M and periodic costs associated with Alternative 3. Additionally, CERCLA Five-Year Reviews would be required for both Alternatives 2 and 3 since UU/UE is not attained. The discounted costs associated with the Five-Year Reviews over the 30-year performance period would be $94,505 for each alternative. The total costs associated with Alternative 4 are the highest among the alternatives since it would include more aggressive and complex activities to remove surface and subsurface MEC that would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor. There are no follow-on costs (i.e., O&M, periodic, or Five-Year Reviews) following the completion of Alternative 4. The detailed breakdown of the costs for the remedial alternatives is provided in Appendix C.

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

Based on the results of the RI and the history of the MRS as the location where the accidental detonation of 2,516 clusters of the M-41 20 lb fragmentation bomb occurred, the potential remains for residual MEC to be present in surface and subsurface soil and sediment on the MRS. The potential presence of MEC on the MRS presents a potential explosive hazard to the Industrial Receptor via direct contact to a maximum exposure depth of 4 feet bgs. The NCP statutory preference for reduction of toxicity, mobility, or volume through treatment is best achieved with Alternative 4 that would attain UU/UE and a negligible probability of exposure for the Industrial Receptor. Based on the evaluation of the NCP criteria, Alternative 2 (LUCs), Alternative 3 (Surface Removal and LUCs), and Alternative 4 (Surface and Subsurface Removal) are effective and implementable. The deciding factor in selecting a remedy will be the lowest-cost alternative that meets the RAOs and is technically and administratively implementable.

The MEC HA (Appendix B) categorizes Alternative 1 as a "moderate potential explosive hazard condition" (i.e. Hazard Level 3). The Hazard Level would not change for Alternative 2, since no planned mass removal of MEC would occur; however, Alternative 2 takes action to mitigate potentially remaining MEC risks at the MRS through engineering and educational controls to restrict direct contact of the Industrial Receptor with the MEC. Alternatives 3 and 4 involve the physical removal of MEC to differing degrees, which both result in a MEC HA Hazard Level of 4, "low potential explosive hazard condition". Although Alternatives 3 and 4 have the same Hazard Level, the MEC HA score is lower for Alternative 4 (355) than for Alternative 3 (390). The lower score for Alternative 4 indicates there is less of an explosive hazard condition due to a more robust removal action that involves both surface and subsurface MEC; whereas, only surface removal of MEC is performed under Alternative 3.

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 and the MEC HA Hazard Level outputs.

6.3 Suggested Alternative

Based on the overall evaluation of alternatives, the Army's suggested alternative is Alternative 4, Surface and Subsurface Removal (UU/UE). This alternative satisfies the RAOs by reducing the unacceptable hazards of MEC for the Industrial Receptor in surface and subsurface soils and in sediment at the saturated and surface water areas at the MRS. Alternative 4 is preferred under CERCLA since it attains UU/UE, is protective of human health and the environment, is ARAR compliant, and provides the best combination of primary balancing attributes that allow for the anticipated future land use.

This recommendation is not a final decision. The Army, in coordination with Ohio EPA, will further evaluate the alternatives for the Block D Igloo MRS in the Proposed Plan that will be presented to the public for review and comment.

Table 6-1. Comparison of Alternatives

CERCLA Evaluation Criteria	Remedial Alternatives			
	Alternative 1 No Action	Alternative 2 LUCs	Alternative 3 Surface Removal and LUCs	Alternative 4 Surface and Subsurface Removal (UU/UE)
Protective of Human Health and Environment	No	Yes	Yes	Yes
Complies with Applicable or Relevant and Appropriate Requirements	Yes	Yes	Yes	Yes
Effective and Permanent	No	Medium	High	Highest
Reduces Toxicity, Mobility, or Volume through Treatment	None (no treatment)	Minimal (Incidental treatment)	Removal of Surface MEC only	Removal of MEC to achieve UU/UE
Short-Term Effectiveness	Low	Medium	High	Highest
Implementable				
Technically Feasible	Yes	Yes	Yes	Yes
Administratively Feasible	No	Yes	Yes	Yes
Costs				
Capital	$0	$626,025	$1,642,116	$7,039,235
O&M (discounted)	$0	$245,094	$245,094	$0
Periodic (discounted)	$0	$27,224	$27,224	$0
Present Worth (Capital + discounted O&M +discounted Periodic Costs)	$0	$898,343	$1,914,434	$7,039,235
Five-Year Reviews (discounted)	$0	$94,505	$94,505	$0
State Acceptance	To be determined			
Community Acceptance	To be determined			
[1]MEC HA Hazard Level Determination	Hazard Level: 3 Score: 640	Hazard Level: 3 Score: 540	Hazard Level: 4 Score: 390	Hazard Level: 4 Score 355

[1] denotes the MEC HA is not a CERCLA Evaluation Criteria but is included to supplement the evaluation of alternatives presented in this Feasibility Study.
CERCLA denotes Comprehensive Environmental Response, Compensation, and Liability Act of 1980.
LUC denotes land-use control.
MEC denotes munitions and explosives of concern.
MEC HA denotes Munitions and Explosives of Concern Hazard Assessment.
UU/UE denotes unlimited use/unrestricted exposure.

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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®

North Atlantic Division, Baltimore District
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April 2018

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ARNG	Army National Guard
Camp Ravenna	Camp Ravenna Joint Military Training Center
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
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
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
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) on an MRS are physical removals and land use controls (LUCs). LUCs are implemented to manage any residual MPPEH hazard remaining at a MRS. LUCs can also be implemented as a stand-alone response without a physical removal.

LUCs consist of various legal mechanisms, educational and engineering control measures, and construction support actions to minimize the potential MPPEH or other hazards for human receptors at an MRS. Instead of eliminating the MPPEH hazard, a LUC remedial action relies on behavior modification and access control strategies to reduce explosive safety 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, 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, 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 hazards;
- Document the obligations, if any, of each agency or entity to protect the surrounding community from associated explosive 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 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
Open Demolition Area #2	RVAAP-004-R-01
Block D Igloo	RVAAP-060-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 an LUC program.
- Capability – Even if an agency has the jurisdiction, authority, and mission to be involved in an 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 an LUC program is critical to its success. The effectiveness of LUCs is increased when local officials are convinced that participation in an 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 Ravenna Joint Military Training Center (Camp Ravenna), is located in northeastern Ohio within Portage and Trumbull Counties. Camp Ravenna 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 Camp Ravenna 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 Camp Ravenna facility, or their having a specific mission to protect the public from potential MPPEH 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
Open Demolition Area #2	Maintenance, natural resource management, and sampling	No changes from current activities, future military training possible.
Block D Igloo	Military training, maintenance, natural resource management, and sampling	No changes anticipated

The MRSs presented in this table are included as part of the facility-wide analysis of IAs. The Open Demolition Area #2 MRS Feasibility Study has not yet been reviewed or received concurrence from the Ohio EPA.

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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 Camp Ravenna. 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 Block D Igloo 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	
Block D Igloo	Annual training for all Camp Ravenna employees	Siebert Stakes and Signage around former impact area only (1.27 acres)	Educational Controls to include the 3Rs of UXO safety Engineering controls to include MRS perimeter fence, Siebert stakes, and signs
	Contractor training as needed upon worker entry to the MRS	None	Monitoring
	National Guard training as needed upon trainee in-brief to Camp Ravenna	None	Future Remedial Action

FSs for the other MRSs will be submitted separately for review and will also include this IA document.

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 Camp Ravenna, 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 and to comply with established protocols for soil/sediment disturbance activities in potential MPPEH 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. Camp Ravenna manages digging activities within existing procedures and does not support the implementation of an MPPEH 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. Camp Ravenna manages contractors that access these MRSs within existing procedures and does not support the implementation of additional MPPEH 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 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 Camp Ravenna 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 O&M costs until UU/UE (i.e. negligible MPPEH 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 (MDEH). 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 may be present and where public access would result in potential exposures. Fences require inspection, maintenance, and repair to remain effective. Based on the Camp Ravenna 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 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 regular patrolling of an MRS by a security officer can ensure that unauthorized personnel do not enter an area with explosive hazards. This control can be implemented alone or in conjunction with other LUCs to ensure that all established LUCs are enforced. As the entire Camp Ravenna facility is regularly 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, Camp Ravenna 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, stressing the importance of the 3Rs—recognize, retreat, and report—of unexploded ordnance safety. Educational controls can be implemented to provide informational materials on potential MPPEH recognition, avoidance, and encounter protocols. 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 Camp Ravenna; however, the 3Rs of unexploded ordnance safety are currently not included in the training. Continued use of educational controls with the addition of the components of the 3R's of explosive safety, 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 Camp Ravenna 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 Camp Ravenna 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 Ravenna 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 Ravenna Joint Military Training Center" and is known as Camp Ravenna. Camp Ravenna 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 Camp Ravenna has been established under License No. DACA27-3-06-

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

Access to Camp Ravenna is limited; however, once authorized visitors are on the property, physical access to the MRSs is unrestricted. Additional information regarding OHARNG at Camp Ravenna 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 Camp Ravenna.
Public Safety Function	OHARNG has public safety functions including: management of safety procedures on Camp Ravenna; the authority to implement LUCs at Camp Ravenna; and the interim controls established to protect personnel on Camp Ravenna.
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 Camp Ravenna 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 Camp Ravenna. 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 Camp Ravenna. However, the ARNG has delegated this authority to the OHARNG for specific purposes of LUC enforcement at Camp Ravenna. 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 Camp Ravenna 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 Camp Ravenna.
Land Use Controls	The OHARNG and the ARNG has authority to implement, maintain, and enforce LUCs at Camp Ravenna 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 Camp Ravenna. The ability to provide funding is affected by budget changes over time, limiting funding for specific Camp Ravenna 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 Camp Ravenna 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 Camp Ravenna would depend on its willingness to maintain communications with Camp Ravenna 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 Camp Ravenna 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 Camp Ravenna is accomplished through the coordination with Camp Ravenna (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 Camp Ravenna 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 Camp Ravenna 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/Camp Ravenna. 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 Camp Ravenna 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 an LUC design or maintenance/oversight contract if programmed and funded by DoD or ARNG.
Desire to Participate	USACE is willing to support ARNG/Camp Ravenna in the development of an 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

Camp Ravenna is fenced at the perimeter (though this fencing was not established as a LUC); 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, Camp Ravenna 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 Fuze and Booster Quarry MRS. 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. However, the addition of the 3Rs of UXO safety to the current educational program may provide additional knowledge on the specific type of contamination anticipated. The OHARNG personnel are trained to deal with MPPEH avoidance and reporting procedures 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 Camp Ravenna 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	
Open Demolition Area #2	• Annual training for all Camp Ravenna employees • Contractor training as needed upon worker entry to the MRS • National Guard training as needed upon trainee in-brief to Camp Ravenna	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

Note:
Bold/Highlighted text identifies the applicable MRS Feasibility Study to which this IA is appended.
The potential LUCs identified for other MRSs will be addressed in the IA for that MRS.
The LUCs presented in this table for other MRSs are included as part of the facility-wide analysis of IAs and may not be considered as approved by the Ohio EPA.

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Appendix B
Munitions and Explosives of Concern Hazard Assessment

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Munitions and Explosives of Concern Hazard Assessment for RVAAP-060-R-01 Block D Igloo Munitions Response Site

Former Ravenna Army Ammunition Plant
Portage and Trumbull Counties, Ohio

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

Prepared for:

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April 23, 2017

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Attachment 1 MEC HA Worksheets

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Acronyms and Abbreviations

ARNG	Army National Guard
bgs	below ground surface
Camp Ravenna	Camp Ravenna Joint Military Training Center
CB&I	CB&I Federal Services LLC
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DMM	discarded military munitions
EPA	U.S. Environmental Protection Agency
ESQD	explosive safety quantity-distance
FS	Feasibility Study
HFD	hazardous fragment distance
lb	pound
LUC	land-use control
MEC	munitions and explosives of concern
MEC HA	*Munitions and Explosives of Concern Hazard Assessment*
MRS	Munitions Response Site
OHARNG	Ohio Army National Guard
RI	Remedial Investigation
RVAAP	Ravenna Army Ammunition Plant
U.S.	United States
USACE	U.S. Army Corps of Engineers
UU/UE	unlimited use/unrestricted exposure
UXO	unexploded ordnance

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1.0 INTRODUCTION

Munitions and explosives of concern (MEC) were identified during the Remedial Investigation (RI) field activities at the Block D Igloo Munitions Response Site (MRS) (RVAAP-060-R-01) located at the former Ravenna Army Ammunition Plant (RVAAP). The RVAAP (Federal Facility Identification No. OH213820736), now known as the Camp Ravenna Joint Military Training Center (Camp Ravenna), is located in northeastern Ohio within Portage and Trumbull Counties.

The presence of MEC represents a potential explosive safety hazard; therefore, a *Munitions and Explosives of Concern Hazard Assessment* (MEC HA) was conducted for the MRS. The MEC HA was prepared in accordance with the *Interim Munitions and Explosives of Concern Hazard Assessment Methodology* (MEC HA Methodology; United States [U.S.] Environmental Protection Agency [EPA], 2008). The MEC HA Methodology was developed through a collaborative, consensus-based approach to promote consistent evaluation of potential explosive hazards at MRSs. The MEC HA Methodology addresses human health and safety concerns associated with the potential exposure to MEC at a MRS, but does not address hazards (explosive or toxic) posed by chemical warfare materiel, MEC that is present underwater, nor environmental or ecological hazards that may be associated with MEC.

At the conclusion of a RI, the MEC HA supports the assessment of the explosive hazards that would remain if no action were taken. The evaluation of the "No Action" alternative helps to identify the MRS conditions and use activities that should be addressed by removal alternatives considered during the Feasibility Study (FS). The MEC HA also provides an assessment of relative hazard reduction associated with remedial action alternatives (surface and/or subsurface cleanup, land-use controls [LUCs], or a combination of these alternatives). The MEC HA, as well as the associated outputs, can provide useful information for several of the nine-criteria analyses that are required for the evaluation of remedial alternatives under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial action program (EPA, 2008).

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2.0 COMPONENTS OF THE MEC HA

The MEC HA is structured into three components consisting of severity, accessibility, and sensitivity. Each of these components requires input factors that have two or more categories. These input factors are assigned a numeric score that is summed to calculate hazard levels. Hazard levels were generated during the RI for the current and future land-use activities only, since no remediation alternatives were generated for the MRS at that time. For the FS, the hazard levels are generated for the response action alternatives that were retained for detailed analysis and evaluated through the CERCLA program's nine-criteria analyses. Table B-1 presents the four hazard levels and the corresponding minimum and maximum scores for each level of the MEC HA.

Table B-1
Summary of the MEC HA Methodology Hazard Levels

Hazard Level	Maximum MEC HA Score	Minimum MEC HA Score	Description
1	1,000	840	Highest potential explosive hazard condition
2	835	725	High potential explosive hazard condition
3	720	530	Moderate potential explosive hazard condition
4	525	125	Low potential explosive hazard condition

MEC HA denotes Munitions and Explosives of Concern Hazard Assessment.

Descriptions for each of the three MEC HA components (severity, accessibility, and sensitivity) and the required input factors that are evaluated to determine the hazard levels for the various land-use scenarios at the Block D Igloo MRS are as follows:

- Severity—The "severity" component is defined in the MEC HA Methodology (EPA, 2008) as "[t]he potential consequences of the effect (i.e., injury or death) on a human receptor should a MEC item detonate." Two input factors are required to determine this component: (1) *Energetic Material Type* and (2) *Location of Human Receptors*. The first factor describes the hazard associated with MEC known or suspected to be present at the MRS. The second factor accounts for the possibility that secondary receptors could be affected in addition to the receptor that initiated the detonation of a MEC item.
- Accessibility—The "accessibility" component is defined in the MEC HA Methodology (EPA, 2008) as "[t]he likelihood that a human receptor will be able to come into contact with a MEC item." The following five input factors are required to determine this component:
  1) *Site Accessibility*, which describes the ease with which people can access the MRS.
  2) *Potential Contact Hours*, which is an estimate of the total number of receptor hours per year. Both the number of receptors and the amount of time they spend at the MRS can affect the likelihood of the receptor encountering MEC.

3) *Amount of MEC* that may be present due to past munitions-related activities at the MRS. This input factor is assessed by determining the type of munitions activities that took place at the MRS (some of the categories are target area, open burning/open detonation, maneuver area, safety buffer area, storage, etc.).

4) *Minimum MEC Depth Relative to the Maximum Receptor Intrusive Depth*, which describes whether MEC items are located where receptor activities take place.

5) *Migration Potential*, which describes the likelihood that MEC items can be moved and potentially exposed by natural processes such as erosion or frost heaving (repeated freeze/thaw cycles).

- Sensitivity—The "sensitivity" component is defined in the MEC HA Methodology (EPA, 2008) as "the likelihood that a MEC item will detonate if a human receptor interacts with it." Two input factors are required to determine this component: (1) *MEC Classification* (unexploded ordnance [UXO] Special Case, UXO, Fuzed Discarded Military Munitions [DMM] Special Case, Fuzed DMM, Unfuzed DMM, and Bulk Explosives), and (2) *MEC Size*. The *MEC Size* input factor is used to account for the ease with which MEC can be moved by a receptor, which increases the likelihood that a receptor will pick it up or otherwise disturb the item. One of two categories is used to describe the MEC size: (1) "small" (MEC that weigh less than 90 pounds [lbs]), or (2) "large" (MEC that weigh 90 lbs or more).

The MEC HA workbook for the Block D Igloo MRS that evaluates the aforementioned components and input factors to generate hazard levels for the current and future land-use activities that were generated during the RI and the response alternatives that are evaluated in the FS is presented in Attachment 1. The following sections discuss the individual components that comprise the MEC HA and provide rationale for the input factors chosen.

3.0 SEVERITY

The two input factors for the "severity" component of the MEC HA, *Energetic Material Type* and *Location of Human Receptors*, are presented below for the Block D Igloo MRS.

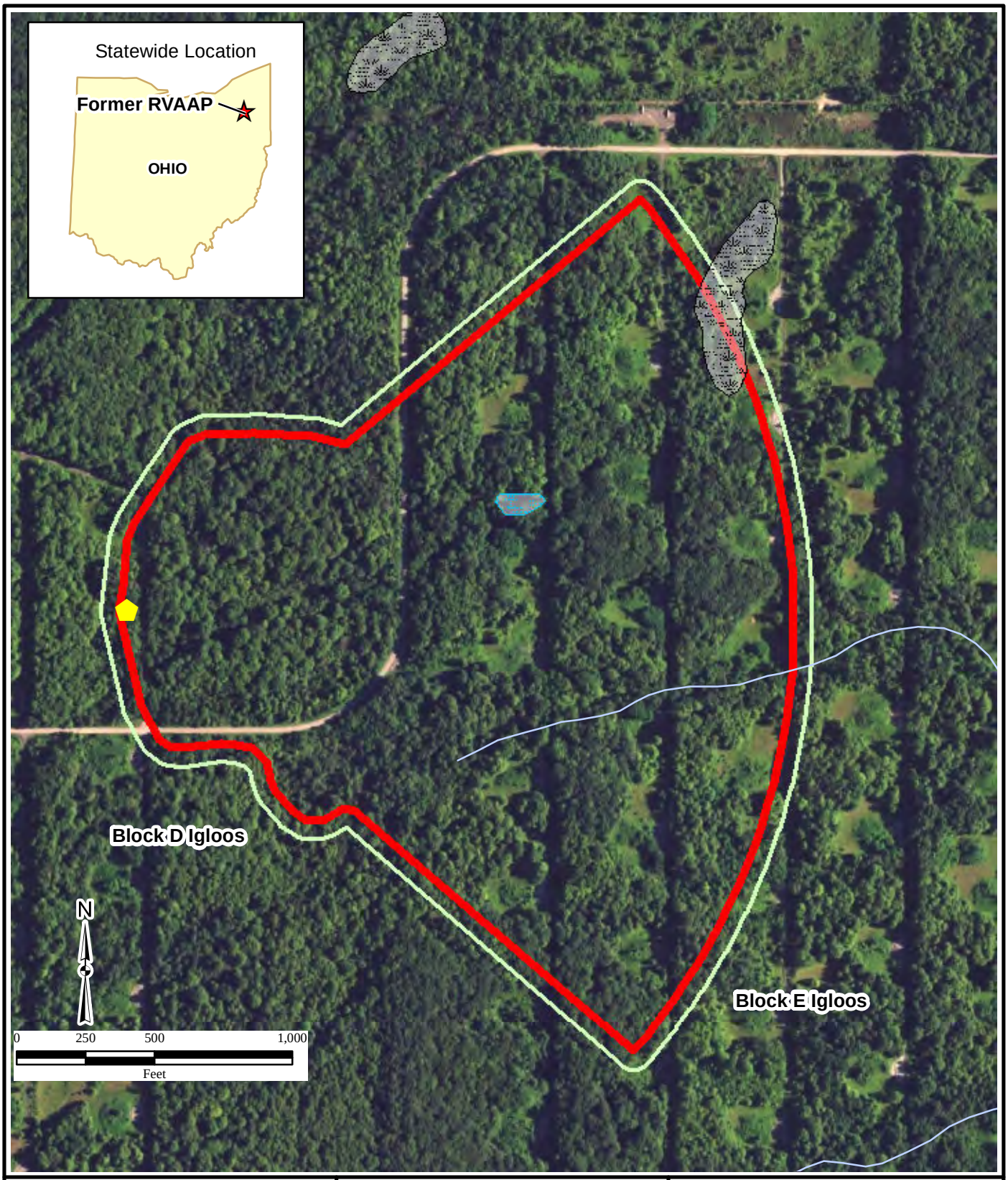
3.1 Energetic Material Type

The presence of the high explosive–filled bombs (M-41 20 lb fragmentation bombs) was confirmed during the field activities at the Block D Igloo MRS. Based on this information; the input factor for the *Energetic Material Type* is determined to be "High Explosives." This input would not change for a future use scenario.

3.2 Location of Human Receptors

Unintentional detonation of MEC could result in injury or death to the individual initiating the detonation and also to other receptors that may be exposed to the overpressure or fragmentation hazards from the MEC detonation. For the *Location of Human Receptors* factor, a determination is made whether there are places where people congregate that are either within the MRS or within the explosive safety quantity-distance (ESQD) arc. The ESQD arc was determined to be 67 feet around the boundary of the MRS and is based on the calculated hazardous fragment distance (HFD) for the M-41 20 lb fragmentation bomb (U.S. Department of Defense, 2009). The HFD is for unintentional detonations that may occur by receptors that may access the MRS. The ESQD for the Block D Igloo MRS is presented on Figure B-1.

Under current conditions, there are no specific areas within the ESQD arc where facility personnel/trespassers would congregate; however, current activities within the Block D Igloo MRS do include maintenance, natural resource management, and environmental sampling activities. The current activities within the MRS are expected to remain the same but may also include training activities that will likely increase or change the location of human receptors. Therefore, there is the potential for human receptors to be located within the MRS or the ESQD arc.



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05/08/2017 JWR
Source CB&I

Legend

- Location of Former Igloo 7-D-15
- Stream
- Jurisdictional Wetland
- Planning Level Survey Wetlands
- ESQD Arc (67 feet)
- Block D Igloo MRS Boundary

Figure B-1
Explosive Safety Quantity-Distance Arc
Block D Igloo MRS
Camp Ravenna/Former RVAAP
Portage/Trumbull Counties, Ohio

4.0 ACCESSIBILITY

The five input factors for the "accessibility" component of the MEC HA (*Site Accessibility*, *Potential Contact Hours*, *Amount of MEC*, *Minimum MEC Depth Relative to the Maximum Receptor Intrusive Depth*, and *Migration Potential*) are presented below for the Block D Igloo MRS.

4.1 Site Accessibility

The 101.6-acre MRS is located in the northern portion of Camp Ravenna and is within the fence line of Camp Ravenna. However, once on the Camp Ravenna property, there are no additional barriers preventing access to the MRS. The input factor for S*ite Accessibility* is determined to be "full accessibility," which indicates that there are few or no physical barriers to entry. This input would not change for the future land-use scenario or the response alternatives that are evaluated in the FS.

4.2 Potential Contact Hours

This section presents the *Potential Contact Hours* for the receptors that may be present at the MRS based on the various land-use scenarios, including current and future land-use scenarios and land-use activities after response alternatives are completed. The activities, receptors, and hours included herein are based on input provided by the U.S. Army Corps of Engineers (USACE) and the Ohio Army National Guard (OHARNG).

4.2.1 Current Use Activities

The areas where MEC associated with the explosion at Igloo 7-D-15 is present are available to facility personnel, contractors, and potential trespassers. The current land use activities at the MRS are maintenance, natural resource management, environmental sampling, and military training. The future land use will not change. The following types of activities, receptors, and hours were assumed for the current use activities at the MRS and were based on input provided by the USACE and the OHARNG during the preparation of the *Final Remedial Investigation Report for RVAAP-019-R-01 Landfill North of Winklepeck MRS and RVAAP-060-R-01 Block D Igloo MRS* (Final RI Report; CB&I Federal Services [CB&I}, 2015):

- National Guard Trainee—20 people per year × 28 days per year × 24 hours per day = 13,440 receptor hours per year
- Security Guard/Maintenance Worker—1 hour per day × 250 days per year = 250 receptor hours per year
- Natural Resources Management—2 people per year × 1 hour per week × 52 weeks = 104 receptor hours per year
- Trespassers—125 people per year × 1 day per person × 2 hours per day = 250 receptor hours per year

The total potential contact time calculated for the current use activities at the MRS is 14,044 receptor hours per year.

4.2.2 Future Use Activities

Future use activities at the MRS were also calculated for the Final RI Report (CB&I, 2015), but the receptors were revised in the FS (and incorporated herein) to include the Industrial Receptor that is considered the representative receptor for the MRS (Army National Guard [ARNG], 2014). The following types of activities, receptors, and hours were developed for the future land-use activities based on input provided by the USACE and the OHARNG during the FS:

- Industrial Receptor—10 people per year × 253 days per person × 6 hours per day = 15,180 receptor hours per year
- Security Guard/Maintenance Worker—1 person per day × 1 hour per day × 250 days per year = 250 receptor hours per year
- Natural Resources Management—2 people per year × 1 hour per week × 52 weeks = 104 receptor hours per year
- Trespassers—125 people per year × 1 day per person × 2 hours per day = 250 receptor hours per year

The total potential contact time calculated for the future use activities at the MRS is 15,784 receptor hours per year.

4.2.3 Land-Use Activities after Response Actions

The MEC HA evaluates the anticipated land-use activities after the completion of each of the response alternatives that are evaluated in the FS. The "No Action" Response Alternative is required in accordance with the CERCLA process and assumes no activities will be conducted to mitigate potential exposures to explosive hazards at the MRS. The receptor hours for this response alternative are considered to be the same as for the current use activities. It is noted here that numbering of the response alternatives in the MEC HA are different than in the FS since the MEC HA evaluates the "No Action" alternative at the conclusion of the RI but not as a specific response alternative following the RI. The response alternatives in the MEC HA where actual response actions are proposed in the FS for the Block D Igloo MRS include the following:

- Response Alternative 1—LUCs (FS Alternative 2)
- Response Alternative 2—Surface Removal with LUCs (FS Alternative 3)
- Response Alternative 3—Surface and Subsurface Removal (FS Alternative 4)

Response Alternatives 1 does not attain unlimited use/unrestricted exposure (UU/UE) or unrestricted access for the Industrial Receptor and; therefore, would require LUCs to prevent unauthorized access. The LUCs include physical controls such as fencing and warning signs to physically restrict and discourage unauthorized receptors from entering the MRS. Camp Ravenna would also implement educational controls consisting of annual general training for facility employees, National Guard trainee in-briefs received upon arrival at Camp Ravenna, and contractor/site worker training received prior to entry on the MRS. Authorized personnel would still be required to access the MRS based on the future land use. For the purposes of the MEC HA, and to provide a conservative evaluation of potential contact hours for Alternative 1, the following receptors and hours were developed based on input provided by the USACE and the OHARNG during the FS:

- Security Guard/Maintenance Worker—1 person per day × 1 hour per day × 250 days per year = 250 receptor hours per year
- Natural Resources Management—2 people per year × 1 hour per week × 52 weeks = 104 receptor hours per year
- Trespassers—125 people per year × 1 day per person × 2 hours per day = 250 receptor hours per year

The total potential contact time calculated for the future use activities at the MRS after the completion of Response Alternative 1 is 604 receptor hours per year. This is substantially less than the 14,044 receptor hours calculated for the Current Land Use with no LUCs. The reduction in the receptor hours for Alternative 1 are solely due to the implementation of the LUCs that would physically prevent unauthorized personnel from entering the MRS.

Response Alternative 2 will not attain UU/UE or a negligible probability of exposure for the Industrial Receptor; however, surface removal would allow for use of the MRS with digging restrictions. LUCs would still be required at the MRS but would be less restrictive and consist of Siebert stakes and warning signs to prevent or discourage non-authorized personnel from entering the area. For the purposes of the MEC HA, and to provide a conservative evaluation of potential contact hours for Response Alternative 2, the following receptors and hours were developed based on input provided by the USACE and the OHARNG during the FS:

- Security Guard/Maintenance Worker—1 person per day × 1 hour per day × 250 days per year = 250 receptor hours per year
- Natural Resources Management—2 people per year × 1 hour per week × 52 weeks = 104 receptor hours per year
- Trespassers—125 people per year × 1 day per person × 2 hours per day = 250 receptor hours per year
- Industrial Receptor—10 people per year × 253 days per person × 6 hours per day = 15,180 receptor hours per year

The total potential contact time calculated for the future use activities at the MRS after the completion of Response Alternative 2 is 15,784 receptor hours per year. Response Alternative 3 includes surface and subsurface removal of MEC at the MRS and would attain UU/UE as well as a negligible probability of exposure for the Industrial Receptor. The potential contact time for the receptors under Response Alternative 3 are considered the same as for Response Alternative 2 since the MRS would be fully accessible.

4.2.4 Determination of Potential Contact Hours Categories

The receptor hours per year for each response alternative are then summed and determined to be in one of the following four categories:

1) Many hours (greater than 1,000,000 receptor hours per year)
2) Some hours (100,000 to 999,999 receptor hours per year)
3) Few hours (10,000 to 99,999 receptor hours per year)
4) Very few hours (less than 10,000 receptor hours per year)

Based on the activities that are assumed to be currently taking place, the approximate number of receptor hours per year was determined to be 14,044 resulting in a category of "few hours." This category represents the "No Action" Response Alternative, which assumes that no response actions will take place to mitigate the potential exposure of explosive hazards to receptors at the MRS. Even though the assumptions for calculating this input factor are somewhat idealized, the calculated number of receptor hours per year is less than 15 percent of the number for the next highest category; therefore, even if the usage assumptions are changed slightly, the category does not change. The receptor hours decrease significantly to 640 for Response Alternative 1 where actions (i.e., engineering and educational controls) will be taken to mitigate unauthorized access to the MRS, resulting in "very few hours." These hours are representative of authorized personnel that would be allowed to enter the MRS and conduct security, maintenance, or natural resource management activities as well as unauthorized personnel (i.e., trespassers) that may enter the MRS and come into contact with MEC. Response Alternatives 2 and 3 involve different levels of MEC removal at the MRS; however, both would allow for access to the MRS and the receptor hours would increase significantly to 15,784 receptor hours per year. This equates to a category of "few hours" and is significantly lower than the hours for the next highest category.

4.3 Amount of MEC

The *Amount of MEC* input factor has nine categories to classify an MRS as follows:

1) Target Area
2) Open Burning/Open Detonation Areas
3) Functional Test Range
4) Burial Pit
5) Maneuver Area
6) Firing Points
7) Safety Buffer Area
8) Storage
9) Explosives-related Industrial Facility

The MEC source at the Block D Igloo MRS (accidental explosion) does not specifically fall into any of these categories; however, each category was evaluated and the category that best represented the MEC source was selected. Igloos within the Block D Igloo MRS were used for munitions storage; therefore, "Storage" was selected as the most appropriate category for the MEC HA. "Storage" is defined as "any facility used for the storage of military munitions, such as earth-covered magazines, above-ground magazines, and open-air storage areas" (EPA, 2008).

4.4 Minimum MEC Depth Relative to Maximum Receptor Intrusive Depth

MEC were found in subsurface soil at a maximum depth of 0.5 feet below ground surface (bgs) during the RI field activities. Based on the RI findings, the minimum depth of munitions was assumed to be 0 feet bgs, since there is a potential for MEC to be present in the surface and subsurface soil.

Intrusive activities are not currently restricted at the MRS, and intrusive activities may occur at the MRS for the future land-use. The maximum depth associated with the Industrial Receptor, the representative receptor for the MRS, is disturbance to 4 feet bgs (ARNG, 2014). Because the shallowest minimum MEC

depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. Therefore, the category for this input factor is "Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC." For future activities, the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, and the intrusive depth overlaps. Therefore, the category for this input factor is "Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC." Only baseline conditions are considered for current and future land-use activities.

Response Alternative 1 (LUCs) does not include the physical removal of any MEC at the MRS to mitigate the potential exposure of explosive hazards to receptors. Although LUCs would be implemented to mitigate unauthorized access to the MRS and prevent intrusive activities, the shallowest minimum MEC depth that would remain (i.e., on the ground surface) after the LUCs are implemented is less than or equal to the deepest intrusive depth (i.e., walking on ground surface), and the intrusive depth overlaps. As a result, the category for this input factor is similar to the current and future land-use activities and is "Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC."

Response Alternative 2 (Surface Removal and LUCs) would remove MEC from the surface only, and no intrusive activities would be conducted to remove subsurface MEC. Although subsurface MEC would remain, the LUCs are intended to mitigate unauthorized access to the MRS and prevent intrusive activities. Because the shallowest minimum MEC depth (i.e., >0 feet bgs) is greater than the deepest intrusive depth (i.e., walking on ground surface), the intrusive depth does not overlap. Therefore, the category for this input factor is "After Cleanup: Intrusive depth does not overlap with subsurface MEC."

Response Alternative 3 (Surface and Subsurface Removal) would remove MEC from both the surface and subsurface and allow for UU/UE for the Industrial Receptor. The probability of exposure to any remaining explosive hazards at the MRS would be negligible. Therefore, the category for this input factor is "After Cleanup: Intrusive depth does not overlap with minimum MEC depth."

4.5 Migration Potential

The MRS is potentially susceptible to frost heave due to seasonally wet soil and poor drainage associated with the soil types; however, the facility has very little difficulty with erosion, since slope is 5 percent or less (AMEC Earth and Environmental, Inc., 2014). In addition, the MRS is located in a heavily forested location at the facility. Therefore, although vertical migration of MEC in the soil may occur, significant migration once on the ground surface is considered to be minimal.

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5.0 SENSITIVITY

The two input factors for the "sensitivity" component of the MEC HA, *MEC Classification* and *MEC Size*, are presented below for the Block D Igloo MRS.

5.1 MEC Classification

The MEC HA Methodology (EPA, 2008) defines six categories of MEC for the following MEC classification input factors:

1) UXO Special Case
2) UXO
3) Fuzed DMM Special Case
4) Fuzed DMM
5) Unfuzed DMM
6) Bulk Explosives

The category selected for the MEC classification was "Fuzed DMM." The term "DMM" per 10 U.S. Code 2710(e)(2) is defined as "military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations." This is supported by the presence of only unarmed munitions in the Block D Igloo MRS. This input would not change for the future land-use scenario and response alternatives.

5.2 MEC Size

The MEC HA indicates that if "any of the items" weigh less than 90 lbs, then the category "small" must be used as the input. The subject fragmentation bombs that accidentally detonated at Igloo 7-D-15 weighed 20 lbs each, and the category used in the MEC HA was "small."

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6.0 MEC HA RESULTS

The input factors for the components that comprise the MEC HA are presented herein, and an explosive hazard level determination for the Block D Igloo MRS has been generated for both the current and future land-use activities, as well as for the anticipated land-use activities after each of the proposed response alternatives are completed. A summary of the MEC HA scoring ranges and the associated hazard level categories are presented in Section 2.0. The MEC HA workbook is an automatically generated report that provides the calculated explosive hazard level determinations based on the inputs discussed in this section. The MEC HA workbook is presented in Attachment 1.

At the conclusion of a RI, the MEC HA supports the assessment of the explosive hazards that would remain if no action were taken. Based on current conditions and future land-use at the MRS, and assuming no action occurs at the MRS, evaluation of the MEC HA resulted in scores of 640 and 615 for the current and future land-use activities, respectively. These scores equate with a Hazard Level of 3 (moderate potential explosive hazard condition).

The MEC HA provides an assessment of relative hazard reduction associated with the response alternatives that are retained for evaluation in the FS. The response alternatives where actual response actions are proposed in the FS for the Block D Igloo MRS include the following:

- Response Alternative 1—LUCs (FS Alternative 3)
- Response Alternative 2—Surface Removal with LUCs (FS Alternative 3)
- Response Alternative 3—Surface and Subsurface Removal (FS Alternative 4)

Evaluation of the MEC HA for Response Alternative 1 where only LUCs will be implemented resulted in a score of 540, which is lower than the score for the current and future land uses that assume "No Action." Similar to the current and future land-use activities, the MEC HA score for Response Alternative 1 equates with a Hazard Level of 3 (moderate potential explosive hazard condition). The slight decrease in the MEC HA score for Response Alternative 1 is solely the result of the decrease in the receptor hours associated with implementing the LUCs that are somewhat protective of the Industrial Receptor.

The response action for Response Alternative 2 includes surface removal only of MEC following by the implementation of LUCs to mitigate the potential for unauthorized personnel from accessing the MRS. No subsurface MEC would be removed under this response alternative. The resulting MEC HA score for Response Alternative 3 is 390, which equates to a Hazard Level of 4 (low potential explosive hazard condition). The reduction in the MEC HA score in comparison to Alternative 1 is due to the decrease in several input factors, in particular "Minimum depth MEC Depth Relative to Maximum Intrusive Depth." This factor decreased because surface MEC would be removed and the LUCs would mitigate receptors from coming into contact with any remaining subsurface MEC.

The response action for Response Alternative 2 includes both surface and subsurface removal of MEC that would attain for UU/UE as well as unrestricted access for the Industrial Receptor. No further actions for MEC would be necessary after the completion of Response Alternative 3. This resulting MEC HA score for Response Alternative 3 is 355, which equates to a Hazard Level of 4 (low potential explosive hazard condition). The score represents a significant decrease from the other response alternatives, in particular Response Alternative 1. The reduction in the MEC HA score in comparison to the other response

alternatives is due to the complete removal of MEC that greatly reduced the input factor for “Minimum depth MEC Depth Relative to Maximum Intrusive Depth.”

Summarily, all of the response alternatives were more protective of potential explosive hazards at the MRS in comparison to conducting “No Action.” The response action for Response Alternative 3 is the complete surface and subsurface removal of MEC that would attain UU/UE as well as unrestricted access for the Industrial Receptor and had the lowest overall MEC HA score.

7.0 REFERENCES

AMEC Earth and Environmental, Inc., 2014. *Integrated Natural Resources Management Plan and Environmental Assessment for the Ravenna Training and Logistics Site and the Ravenna Army Ammunition Plant, Portage and Trumbull Counties, Ohio*, prepared for the Ohio Army National Guard, December.

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-019-R-01 Landfill North of Winklepeck MRS and RVAAP-060-R-01 Block D Igloo MRS,* Version 1.0, prepared for the U.S. Army Corps of Engineers, Baltimore District. March.

U.S. Department of Defense, 2009. *DoD Ammunition and Explosive Safety Standards*, 6055.09-STD, Incorporating Change 2, August 21.

U.S. Environmental Protection Agency (EPA), 2008. *Munitions and Explosives of Concern Hazard Assessment Methodology*, Interim, Washington, D.C., October.

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Attachment 1
MEC HA Worksheets

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MEC HA Workbook v1.02

December-07

Overview

This workbook is a tool for project teams to assess explosive hazards to human receptors at munitions response sites (MRSs) following the Munitions and Explosives of Concern Hazard Assessment (MEC HA) methodology. The MEC HA allows a project team to evaluate potential explosive hazard associated with a site, given current site conditions, under various cleanup, land use activities, and land use control alternatives. A complete description of the methodology can be found in the MEC HA Guidance (Public Review Draft, November 2006). Please reference this guidance when completing the worksheets.

Instructions

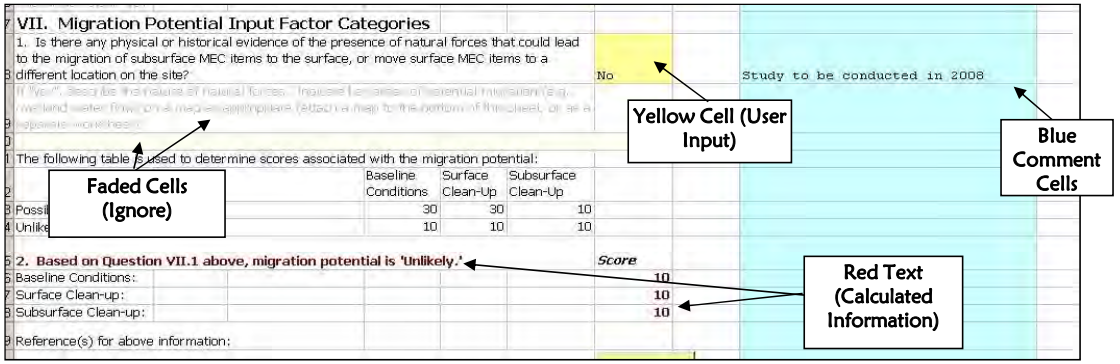
1. Open this file. Enable macros if prompted to do so. This spreadsheet will not work if your security setting is set to 'high' or 'very high'. To change your security level, go to the menu bar and select Tools/Macro/Security. Then close and reopen this spreadsheet.

2. This MS Excel workbook contains 9 worksheets, designed to be used in order. After the '***Instructions***' sheet, the first 5 sheets ask for information about the following topics:

Summary Info - General information regarding the site.
Munitions/Explosive Info - MECs and bulk explosives present at the site.
Current and Future Activities - Current land use activites as well as planned future activities, if any.
Remedial-Removal Action - General information regarding remediation/removal alternatives being considered for the site.
Post-Response Land Use - Land use activities associated with the alternatives listed in the 'Remedial-Removal Action' sheet.

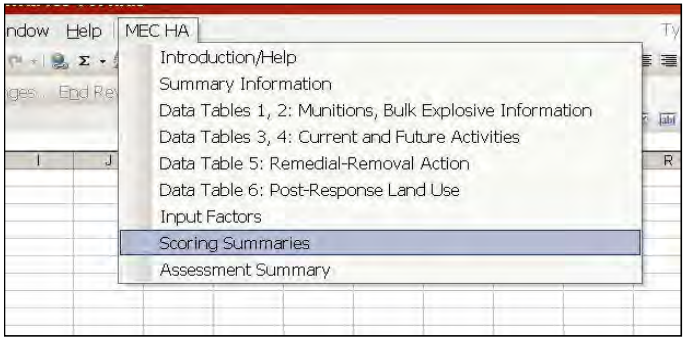
The remaining 3 sheets calculate and summarize the scores. The ***Input Factors*** sheet performs the Input Factor Score calculations, which are summarized in the ***Scoring Summaries*** sheet. The ***Hazard Level*** sheet presents the Hazard Level Category for current use activities, future use activities, and each response alternative based on the respective scores.

3. Starting with the ***Summary Info*** sheet, fill in any yellow cells. Some cells have drop-down lists from which you can select an answer. Select the cell. A down arrow to the right indicates that a drop-down list is available. Yellow buttons can be used to enter reference information. Blue cells can be used for any general comments you wish to make. Any faded cells can be ignored--these are questions that the spreadsheet has determined are not relevant for your situation.

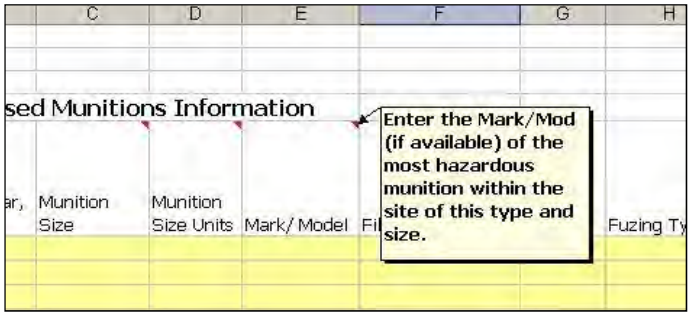


The computer will calculate information based on your inputs. Calculated information will appear as red text.

4. The MEC HA menu bar can be used to navigate to different worksheets.



5. Small red triangles in the upper-right corners indicate that help text is available by putting the mouse cursor on that cell.



MEC HA Summary Information

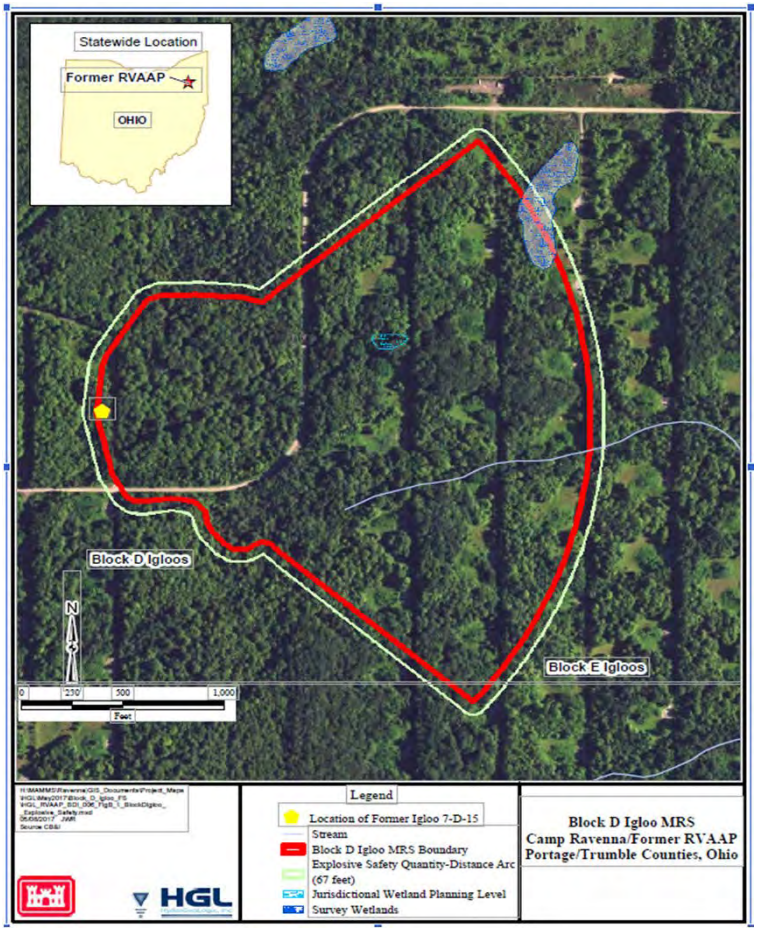
		Comments
Site ID:	OH5210020736, RVAAP-060-R-01	
Date:	9/22/2017	
Please identify the single specific area to be assessed in this hazard assessment. From this point forward, all references to "site" or "MRS" refer to the specific area that you have defined.		
A. Enter a unique identifier for the site:		
RVAAP-060-R-01 Block D Igloo MRS Feasibility Study		
Provide a list of information sources used for this hazard assessment. As you are completing the worksheets, use the "Select Ref(s)" buttons at the ends of each subsection to select the applicable information sources from the list below.		
Ref. No.	Title (include version, publication date)	
1	RI Work Plan, Final, March 2011.	
2	RI Report, Final, March 2015	
3	Technical Memorandum, Final, February, 2014	
4	DoD Ammunition and Explosive Safety Standards, 6055.09-STD, August 2009.	
5	FS Report, Preliminary Draft, May 2017	
6		
7		
8		
B. Briefly describe the site:		
1. Area (include units):	101.6 acres	
2. Past munitions-related use:		
Storage		In 1943 Igloo 7-D-15 accidentaily exploded which resulted in the detonation of 2,516 clusters of 20-lb fragmentation bombs (M-41).
3. Current land-use activities (list all that occur):		
Current activities at the MRS include military training, security activities, maintenance activities, and natural resource management activities that primarily involve foot traffic only.		
4. Are changes to the future land-use planned?	Yes	
5. What is the basis for the site boundaries?		
The Block D Igloo MRS is 101.6 acres and extends from the location of former Igloo D-7-15 to the east towards the “E” Block igloos a distance 2,389 feet. The distance of 2,389 feet was derived from a boundary evaluation that was conducted for the remedial investigation (RI) and conservatively represents the furthest distance that an M-41 20-lb bomb, intact or in pieces, could have traveled as a result of the 1943 explosion. The MRS includes a 100 foot buffer zone beyond the bound lateral extent of MPPEH that was found during the RI		
6. How certain are the site boundaries?		
Certain. Based on the above calculations and corroborated by field investigation activities.		
Reference(s) for Part B:		
RI Work Plan, Final, March 2011.		
RI Report, Final, March 2015		

C. Historical Clearances

1. Have there been any historical clearances at the site? No, none
2. If a clearance occurred:
   a. What year was the clearance performed?
   b. Provide a description of the clearance activity (e.g., extent, depth, amount of munitions-related items removed, types and sizes of removed items, and whether metal detectors were used):

Reference(s) for Part C:

D. Attach maps of the site below (select 'Insert/Picture' on the menu bar.)



Site ID: **OH5210020736, RVAAP-060-R-01**
Date: **9/22/2017**

Cased Munitions Information

Item No.	Munition Type (e.g., mortar, projectile, etc.)	Munition Size	Munition Size Units	Mark/ Model	Energetic Material Type	Is Munition Fuzed?	Fuzing Type	Fuze Condition	Minimum Depth for Munition (ft)	Location of Munitions	Comments (include rationale for munitions that are "subsurface only")
1	Bombs	20	lb	AN-M41	High Explosive	Yes	Time	UNK	0	Subsurface Only	MEC found during RI intrusive investigations. Shallowest MEC item found at 1 inch.
2	Fuzes			AN-M110A1			Time	UNK	0	Subsurface Only	MEC fuze found during RI intrusive investigation. Shallowest MEC item found at 1 inch.
3											
4											
5											
6											
7											
8											
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10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

Reference(s) for table above:

RI Report, Final, March 2015

Site ID: **OH5210020736, RVAAP-060-R-01**
Date: **9/22/2017**

Activities Currently Occurring at the Site

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Trespassers	125	2	**250**	0	1 day/year x 2 hours/day
2	Natural Resources Management	2	52	**104**	0	1 hour/week x 52 weeks
3	Security Guard/Maintenance Worker	1	250	**250**	0	1 hour/day x 250 days/year
4	National Guard Trainee	20	672	**13,440**	7	28 days/year x 24 hours/day
5						
6						
7						
8						
9						
10						
11						
12						
			Total Potential Contact Time (receptor hrs/yr):	**14,044**		
			Maximum intrusive depth at site (ft):		**7**	

Reference(s) for table above:

RI Report, Final, March 2015
Technical Memorandum, Final, February, 2014

Activities Planned for the Future at the Site (If any are planned: see 'Summary Info' Worksheet, Question 4)

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Trespassers	125	2	**250**	4	1 day/year x 2 hours/day
2	Natural Resources Management	2	52	**104**	4	1 hour/week x 52 weeks
3	Security Guard/Maintenance Worker	1	250	**250**	4	1 hour/day x 250 days/year
4	Industrial Receptor	10	1,518	**15,180**	4	253 days/year x 6 hours/day
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			**15,784**		
	Maximum intrusive depth at site (ft):				**4**	

Reference(s) for table above:

RI Report, Final, March 2015; Technical Memorandum, Final, February, 2014

Site ID: **OH5210020736, RVAAP-060-R-01**
Date: **9/22/2017**

Planned Remedial or Removal Actions

Response Action No.	Response Action Description	Expected Resulting Minimum MEC Depth (ft)	Expected Resulting Site Accessibility	Will land use activities change if this response action is implemented?	What is the expected scope of cleanup?	Comments
1	Land Use Controls (LUCs)	0	Very Limited Accessibility	Yes	No MEC cleanup	
2	Surface Removal and LUCs	0.5	Moderate Accessibility	Yes	cleanup of MECs located on the surface only	Cleanup of MEC on or just below the ground surface
3	Surface and Subsurface Removal		Full Accessibility	No	cleanup of MECs located both on the surface and subsurface	Cleanup MEC to maximum exposure depth (4 feet).
4						
5						
6						

For those alternatives where you answered 'No' in Column E, are land-use activities to be assessed against current or future land uses? | Future |

Reference(s) for table above:

RI Report, Final, March 2015

Attachment 1
Munitions and Explosives of Concern Hazard Assessment Worksheets
RVAAP-060-R-01 Block D Igloo MRS
Camp Ravenna/Former Ravenna Army Ammunition Plant

Site ID: **OH5210020736, RVAAP-060-R-01**
Date: **9/22/2017**

This worksheet needs to be completed for each remedial/removal action alternative listed in the 'Remedial-Removal Action' worksheet that will cause a change in land use.

Land Use Activities Planned After Response Alternative #1: Land Use Controls (LUCs)

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Trespassers	125	2	**250**	0	1 day/year x 2 hours/day
2	Natural Resources Management	2	52	**104**	0	1 hour/week x 52 weeks
3	Security Guard/Maintenance Worker	1	250	**250**	0	1 hour/day x 250 days/year
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr): **604**
Maximum intrusive depth at site (ft): **0**

Reference(s) for table above:
FS Report, Preliminary Draft, May 2015
Technical Memorandum, Final, February, 2014

Land Use Activities Planned After Response Alternative #2: Surface Removal and LUCs

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Trespassers	125	2	**250**	0	1 day/year x 2 hours/day
2	Natural Resources Management	2	52	**104**	0	1 hour/week x 52 weeks
3	Security Guard/Maintenance Worker	1	250	**250**	0	1 hour/day x 250 days/year
4	Industrial Receptor	10	1,518	**15,180**	0	253 days/year x 6 hours/day
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr): **15,784**
Maximum intrusive depth at site (ft): **0**

Reference(s) for table above:

Land Use Activities Planned After Response Alternative #3: Surface and Subsurface Removal

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	
1	Trespassers	125	2	**250**	4	1 day/year x 2 hours/day
2	Natural Resources Management	2	52	**104**	4	1 hour/week x 52 weeks
3	Security Guard/Maintenance Worker	1	250	**250**	4	1 hour/day x 250 days/year
4	Industrial Receptor	10	1,518	**15,180**	4	253 days/year x 6 hours/day
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			**15,784**		
	Maximum intrusive depth at site (ft):				**4**	

Reference(s) for table above:
FS Report, Preliminary Draft, May 2015
Technical Memorandum, Final, February, 2014

Site ID: **OH5210020736, RVAAP-060-R-01**
Date: **9/22/2017**

Energetic Material Type Input Factor Categories

The following table is used to determine scores associated with the energetic materials. Materials are listed in order from most hazardous to least hazardous.

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
High Explosive and Low Explosive Filler in Fragmenting Rounds	100	100	100
White Phosphorus	70	70	70
Pyrotechnic	60	60	60
Propellant	50	50	50
Spotting Charge	40	40	40
Incendiary	30	30	30

The most hazardous type of energetic material listed in the 'Munitions, Bulk Explosive Info' Worksheet falls under the category 'High Explosive and Low Explosive Filler in Fragmenting Rounds'.

	Score
Baseline Conditions:	**100**
Surface Cleanup:	**100**
Subsurface Cleanup:	**100**

Location of Additional Human Receptors Input Factor Categories

1. What is the Explosive Safety Quantity Distance (ESQD) from the Explosive Siting Plan or the Explosive Safety Submission for the MRS?	67	feet
2. Are there currently any features or facilities where people may congregate within the MRS, or within the ESQD arc?	Yes	

3. Please describe the facility or feature.

Portions of the Block D Investigation Area are used as a maintenance area during NG training.

MEC Item(s) used to calculate the ESQD for current use activities

Comments

The ESQD is the HFD for the M41 20lb bomb in DoD, 2009.

Item #1. Bombs (20lb, High Explosive)

The following table is used to determine scores associated with the location of additional human receptors (current use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

4. Current use activities are 'Inside the MRS or inside the ESQD arc', based on Question 2.'	***Score***
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**30**

5. Are there future plans to locate or construct features or facilities where people may congregate within the MRS, or within the ESQD arc?	Yes

6. Please describe the facility or feature.

Small arms range complexes and ground based training areas.

MEC Item(s) used to calculate the ESQD for future use activities

Item #1. Bombs (20lb, High Explosive)

The following table is used to determine scores associated with the location of additional human receptors (future use activities):

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Inside the MRS or inside the ESQD arc	30	30	30
Outside of the ESQD arc	0	0	0

7. Future use activities are 'Inside the MRS or inside the ESQD arc', based on Question 5.'	***Score***
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**30**

Site Accessibility Input Factor Categories

The following table is used to determine scores associated with site accessibility:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Full Accessibility	No barriers to entry, including signage but no fencing	80	80	80
Moderate Accessibility	Some barriers to entry, such as barbed wire fencing or rough terrain	55	55	55
Limited Accessibility	Significant barriers to entry, such as unguarded chain link fence or requirements for special transportation to reach the site	15	15	15
Very Limited Accessibility	A site with guarded chain link fence or terrain that requires special equipment and skills (e.g., rock climbing) to access	5	5	5

Current Use Activities

Score

Select the category that best describes the site accessibility under the current use scenario:

Full Accessibility

Baseline Conditions: **80**
Surface Cleanup: **80**
Subsurface Cleanup: **80**

Future Use Activities

Select the category that best describes the site accessibility under the future use scenario:

Moderate Accessibility

Baseline Conditions: **55**
Surface Cleanup: **55**
Subsurface Cleanup: **55**

Reference(s) for above information:

RI Report, Final, March 2015

Response Alternative No. 1: Land Use Controls (LUCs)

Based on the 'Planned Remedial or Removal Actions' Worksheet, this alternative will lead to 'Very Limited Accessibility'.

Baseline Conditions:	**5**
Surface Cleanup:	**5**
Subsurface Cleanup:	**5**

Response Alternative No. 2: Surface Removal and LUCs

Based on the 'Planned Remedial or Removal Actions' Worksheet, this alternative will lead to 'Moderate Accessibility'.

Baseline Conditions:	**55**
Surface Cleanup:	**55**
Subsurface Cleanup:	**55**

Response Alternative No. 3: Surface and Subsurface Removal

Based on the 'Planned Remedial or Removal Actions' Worksheet, this alternative will lead to 'Full Accessibility'.

Baseline Conditions:	**80**
Surface Cleanup:	**80**
Subsurface Cleanup:	**80**

Potential Contact Hours Input Factor Categories

The following table is used to determine scores associated with the total potential contact time:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Many Hours	≥1,000,000 receptor-hrs/yr	120	90	30
Some Hours	100,000 to 999,999 receptor hrs/yr	70	50	20
Few Hours	10,000 to 99,999 receptor-hrs/yr	40	20	10
Very Few Hours	<10,000 receptor-hrs/yr	15	10	5

Current Use Activities:

Input factors are only determined for baseline conditions for current use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **14,044** receptor hrs/yr
Based on the table above, this corresponds to a input factor score for baseline conditions of: **40** Score

Future Use Activities:

Input factors are only determined for baseline conditions for future use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **15,784** receptor hrs/yr
Based on the table above, this corresponds to a input factor score of: **40** Score

Response Alternative No. 1: Land Use Controls (LUCs)

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will change if this alternative is implemented.

Total Potential Contact Time, based on the contact time listed for this alternative (see 'Post-Response Land Use' Worksheet) **604**

Based on the table above, this corresponds to input factor scores of: ***Score***

Baseline Conditions: **15**
Surface Cleanup: **10**
Subsurface Cleanup: **5**

Response Alternative No. 2: Surface Removal and LUCs

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will change if this alternative is implemented.

Total Potential Contact Time, based on the contact time listed for this alternative (see 'Post-Response Land Use' Worksheet)	**15,784**
Based on the table above, this corresponds to input factor scores of:	***Score***
Baseline Conditions:	**40**
Surface Cleanup:	**20**
Subsurface Cleanup:	**10**

Response Alternative No. 3: Surface and Subsurface Removal

Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.

Total Potential Contact Time based on the contact time listed for future use activities (see 'Current and Future Activities' Worksheet)	**15,784**
Based on the table above, this corresponds to input factor scores of:	***Score***
Baseline Conditions:	**40**
Surface Cleanup:	**20**
Subsurface Cleanup:	**10**

Amount of MEC Input Factor Categories

The following table is used to determine scores associated with the Amount of MEC:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Target Area	Areas at which munitions fire was directed	180	120	30
OB/OD Area	Sites where munitions were disposed of by open burn or open detonation methods. This category refers to the core activity area of an OB/OD area. See the "Safety Buffer Areas" category for safety fans and kick-outs.	180	110	30
Function Test Range	Areas where the serviceability of stored munitions or weapons systems are tested. Testing may include components, partial functioning or complete functioning of stockpile or developmental items.	165	90	25
Burial Pit	The location of a burial of large quantities of MEC items.	140	140	10
Maneuver Areas	Areas used for conducting military exercises in a simulated conflict area or war zone	115	15	5
Firing Points	The location from which a projectile, grenade, ground signal, rocket, guided missile, or other device is to be ignited, propelled, or released.	75	10	5
Safety Buffer Areas	Areas outside of target areas, test ranges, or OB/OD areas that were designed to act as a safety zone to contain munitions that do not hit targets or to contain kick-outs from OB/OD areas.	30	10	5
Storage	Any facility used for the storage of military munitions, such as earth-covered magazines, above-ground magazines, and open-air storage areas.	25	10	5
Explosive-Related Industrial Facility	Former munitions manufacturing or demilitarization sites and TNT production plants	20	10	5

Select the category that best describes the ***most hazardous*** amount of MEC: ***Score***

Storage

Baseline Conditions: **25**
Surface Cleanup: **10**
Subsurface Cleanup: **5**

In 1943 Igloo 7-D-15 accidentally exploded which resulted in the detonation of 2,516 clusters of 20-lb fragmentation bombs (M-41).

Minimum MEC Depth Relative to the Maximum Intrusive Depth Input Factor Categories

Current Use Activities

The shallowest minimum MEC depth, based on the 'Cased Munitions Information' Worksheet: **0** ft
The deepest intrusive depth: **7** ft

The table below is used to determine scores associated with the minimum MEC depth relative to the maximum intrusive depth:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240	150	95
Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.	240	50	25
Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.	150	N/A	95
Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth does not overlap with minimum MEC depth.	50	N/A	25

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth will overlap after cleanup. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.' For 'Current Use Activities', only Baseline Conditions are considered.	**240** ***Score***	
Future Use Activities		
Deepest intrusive depth:	**4** ft	
Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'. For 'Future Use Activities', only Baseline Conditions are considered.	**240** ***Score***	
Response Alternative No. 1: Land Use Controls (LUCs)		
Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet):	**0** ft	
Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will change if this alternative is implemented.		
Maximum Intrusive Depth, based on the maximum intrusive depth listed for this alternative (see 'Post-Response Land Use' Worksheet)	**0** ft	No intrusive activities allowed.
Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'		
	Score	
Baseline Conditions:	**240**	
Surface Cleanup:		
Subsurface Cleanup:		

Response Alternative No. 2: Surface Removal and LUCs			
Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet):	**0.5**	ft	
Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will change if this alternative is implemented.			
Maximum Intrusive Depth, based on the maximum intrusive depth listed for this alternative (see 'Post-Response Land Use' Worksheet)	**0**	ft	No intrusive activities allowed.
Because the shallowest minimum MEC depth is greater than the deepest intrusive depth, the intrusive depth does not overlap. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.'			
	Score		
Baseline Conditions:			
Surface Cleanup:	**50**		
Subsurface Cleanup:			
Response Alternative No. 3: Surface and Subsurface Removal			
Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet):	**NA**	ft	All surface and subsurface MEC removed.
Based on the 'Planned Remedial or Removal Actions' Worksheet, land use activities will not change if this alternative is implemented.			
Maximum Intrusive Depth, based on the maximum intrusive depth listed for future use activities (see 'Current and Future Activities' Worksheet)	**4**	ft	
Because the shallowest minimum MEC depth is greater than the deepest intrusive depth, the intrusive depth does not overlap. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.'			
	Score		
Baseline Conditions:			
Surface Cleanup:			
Subsurface Cleanup:	**25**		

Migration Potential Input Factor Categories

Is there any physical or historical evidence that indicates it is possible for natural physical forces in the area (e.g., frost heave, erosion) to expose subsurface MEC items, or move surface or subsurface MEC items?

If "yes", describe the nature of natural forces. Indicate key areas of potential migration (e.g., overland water flow) on a map as appropriate (attach a map to the bottom of this sheet, or as a separate worksheet).

Frost heave throughout MRS

The following table is used to determine scores associated with the migration potential:

	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Possible	30	30	10
Unlikely	10	10	10

Based on the question above, migration potential is 'Possible.'

	Score
Baseline Conditions:	**30**
Surface Cleanup:	**30**
Subsurface Cleanup:	**10**

Reference(s) for above information:

RI Report, Final, March 2015

MEC Classification Input Factor Categories

Cased munitions information has been inputed into the 'Munitions, Bulk Explosive Info' Worksheet; therefore, bulk explosives do not comprise all MECs for this MRS.

The 'Amount of MEC' category is 'Storage'. It is assumed that the MEC items in this MRS are DMM.

Has a technical assessment shown that MEC in the OB/OD Area is DMM?

Are any of the munitions listed in the 'Munitions, Bulk Explosive Info' Worksheet:

- Submunitions
- Rifle-propelled 40mm projectiles (often called 40mm grenades)
- Munitions with white phosphorus filler
- High explosive anti-tank (HEAT) rounds
- Hand grenades
- Fuzes
- Mortars

At least one item listed in the 'Munitions, Bulk Explosive Info' Worksheet was identified as 'fuzed'.

The following table is used to determine scores associated with MEC classification categories:

Fuzed DMM	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
UXO Special Case	180	180	180
UXO	110	110	110
Fuzed DMM Special Case	105	105	105
Fuzed DMM	55	55	55
Unfuzed DMM	45	45	45
Bulk Explosives	45	45	45

Based on your answers above, the MEC classification is 'Fuzed DMM'.

	Score
Baseline Conditions:	**55**
Surface Cleanup:	**55**
Subsurface Cleanup:	**55**

MEC Size Input Factor Categories

The following table is used to determine scores associated with MEC Size:

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Small	Any munitions (from the 'Munitions, Bulk Explosive Info' Worksheet) weigh less than 90 lbs; small enough for a receptor to be able to move and initiate a detonation	40	40	40
Large	All munitions weigh more than 90 lbs; too large to move without equipment	0	0	0

Based on the definitions above and the types of munitions at the site (see 'Munitions, Bulk Explosive Info' Worksheet), the MEC Size Input Factor is: `Small`

	Score
Baseline Conditions:	**40**
Surface Cleanup:	**40**
Subsurface Cleanup:	**40**

Scoring Summary

Site ID:	OH5210020736, RVAAP-060-R-01	a. Scoring Summary for Current Use Activities	
Date:	9/22/2017	Response Action Cleanup:	No Response Action
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		10,000 to 99,999 receptor-hrs/yr	40
V. Amount of MEC		Storage	25
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		Fuzed DMM	55
IX. MEC Size		Small	40
		Total Score	**640**
		Hazard Level Category	**3**

Site ID:	OH5210020736, RVAAP-060-R-01	b. Scoring Summary for Future Use Activities	
Date:	9/22/2017	Response Action Cleanup:	No Response Action
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		10,000 to 99,999 receptor-hrs/yr	40
V. Amount of MEC		Storage	25
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		Fuzed DMM	55
IX. MEC Size		Small	40
		Total Score	**615**
		Hazard Level Category	**3**

Site ID:	OH5210020736, RVAAP-060-R-01	c. Scoring Summary for Response Alternative 1: Land Use Controls (LUCs)	
Date:	9/22/2017	Response Action Cleanup:	No MEC cleanup
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Very Limited Accessibility	5
IV. Potential Contact Hours		<10,000 receptor-hrs/yr	15
V. Amount of MEC		Storage	25
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		Fuzed DMM	55
IX. MEC Size		Small	40
		Total Score	**540**
		Hazard Level Category	**3**

Site ID:	OH5210020736, RVAAP-060-R-01	d. Scoring Summary for Response Alternative 2: Surface Removal and LUCs	
Date:	9/22/2017	Response Action Cleanup:	cleanup of MECs located on the surface only
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Moderate Accessibility	55
IV. Potential Contact Hours		10,000 to 99,999 receptor-hrs/yr	20
V. Amount of MEC		Storage	10
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.	50
VII. Migration Potential		Possible	30
VIII. MEC Classification		Fuzed DMM	55
IX. MEC Size		Small	40
		Total Score	**390**
		Hazard Level Category	**4**

Site ID:	OH5210020736, RVAAP-060-R-01	e. Scoring Summary for Response Alternative 3: Surface and Subsurface Removal	
Date:	9/22/2017	Response Action Cleanup:	cleanup of MECs located both on the surface and subsurface
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		10,000 to 99,999 receptor-hrs/yr	10
V. Amount of MEC		Storage	5
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface, After Cleanup: Intrusive depth does not overlap with subsurface MEC.	25
VII. Migration Potential		Possible	10
VIII. MEC Classification		Fuzed DMM	55
IX. MEC Size		Small	40
		Total Score	**355**
		Hazard Level Category	**4**

MEC HA Hazard Level Determination		
Site ID: OH5210020736, RVAAP-060-R-01 **Date:** 9/22/2017	**Hazard Level Category**	**Score**
a. Current Use Activities	3	640
b. Future Use Activities	3	615
c. Response Alternative 1: Land Use Controls (LUCs)	3	540
d. Response Alternative 2: Surface Removal and LUCs	4	390
e. Response Alternative 3: Surface and Subsurface Removal	4	355
f. Response Alternative 4:		
g. Response Alternative 5:		
h. Response Alternative 6:		
Characteristics of the MRS		
Is critical infrastructure located within the MRS or within the ESQD arc?	No	
Are cultural resources located within the MRS or within the ESQD arc?	No	
Are significant ecological resources located within the MRS or within the ESQD arc?	No	

Appendix C
Feasibility Study Cost Summary Tables

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Table C-1
Alternative 2: Land Use Controls - Cost Summary
RVAAP-060-R-01 Block D Igloo MRS

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Land Use Control Implementation Plan				
Land Use Control Implementation Plan	Lump Sum	$9,889	1	$9,889
Subtotal				**$9,889**
Fence and Warning Sign Installation				
Fence and Warning Sign Installation	Linear Feet	$36	12,215	$436,411
Subtotal				**$436,411**
Institutional Controls				
Initial Standard Awareness Training	Lump Sum	$5,554	1	$5,554
Training Materials	Lump Sum	$1,788	1	$1,788
Subtotal				**$7,342**
	SUBTOTAL			**$453,641**
	SUPERVISION AND ADMIN @ 8%			$36,291
	CONTINGENCY @ 30%			$136,092
	TOTAL CAPITAL COSTS			**$626,025**
ANNUAL O&M COSTS				
Institutional Control Maintenance				
Annual Standard Awareness Training	Lump Sum	$2,754	30	$82,607
Annual Inspections	Lump Sum	$6,075	30	$182,250
Subtotal				**$264,857**
	SUBTOTAL (ANNUALLY)			**$264,857**
	SUPERVISION AND ADMIN @ 8%			$21,189
	CONTINGENCY @ 30%			$79,457
	TOTAL ANNUAL O&M COSTS (30 Years)			**$365,503**
	O&M PRESENT WORTH (2.8%)			**$245,094**
PERIODIC COSTS				
Incidental Destruction of MDEH (Years 5, 10, 15, 20, 25, 30)				
Incidental Destruction of MDEH	Each	$5,186	6	$31,113
Subtotal				**$31,113**
	SUPERVISION AND ADMIN @ 8%			$2,489
	CONTINGENCY @ 30%			$9,334
	TOTAL PERIODIC COSTS (30 Years)			**$42,936**
	PERIODIC PRESENT WORTH (2.8%)			**$27,224**
TOTAL ALTERNATIVE COST (Capital + O&M Present Worth + Periodic Present Worth)				**$898,343**
FIVE-YEAR REVIEWS				
Five Year Reviews (Years 5, 10, 15, 20, 25, 30)				
Five Year Reviews	Each	$18,001	6	$108,007
Subtotal				**$108,007**
	SUPERVISION AND ADMIN @ 8%			$8,641
	CONTINGENCY @ 30%			$32,402
	TOTAL FIVE-YEAR REVIEWS (30 Years)			**$149,049**
	FIVE-YEAR REVIEWS PRESENT WORTH (2.8%)			**$94,505**

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 C-2
Alternative 2: Land Use Controls - Cost Elements
RVAAP-060R-01 Block D Igloo MRS

TASK	SUBTASK	TASK DESCRIPTION	LABOR HOURS	LABOR DOLLARS	OTHER DIRECT CHARGES	TRAVEL	SUB-CONTRACTORS	SUBTASK TOTAL	TASK TOTAL
1		**Land Use Control Implementation Plan**							**$9,889**
	1.1	Land Use Control Implementation Plan	90	$9,620	$269			$9,889	
2		**Fence and Warning Sign Installation**							**$436,411**
	2.1	Fence and Warning Sign Installation	992	$64,641	$4,272	$25,477	$342,020	$436,411	
3		**Institutional Controls**							**$7,342**
	3.1	Initial Standard Awareness Training	51	$4,066	$269	$1,220		$5,554	
	3.2	Training Materials	22	$1,788				$1,788	
4		**Institutional Control Maintenance**							**$8,829**
	4.1	Annual Standard Awareness Training	24	$1,265	$269	$1,220		$2,754	
	4.2	Annual Inspections	72	$3,907		$2,168		$6,075	
5		**Five-Year Reviews**							**$18,001**
	5.1	5-Year Review Report	180	$17,863	$138			$18,001	
6		**Incidential Destruction of MEC**							**$5,186**
	6.1	Incidental Destruction of MEC	15	$1,818	$988	$2,218	$162	$5,186	
		TOTAL	**1,446**	**104,968**	**6,205**	**32,302**	**342,182**		

[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 C-3
Alternative 2: Land Use Controls - Task 1.0 Details
RVAAP-060-R-01 Block D Igloo 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 (20lbs)	$23.00	3	$69	3	$69
Printing	$200.00	1	$200	1	$200
TOTAL OTHER DIRECT COSTS			**$269**		**$269**
TOTAL COSTS			**$9,889**		**$9,889**

ASSUMPTIONS:

Based on existing interim controls currently in place for all of Camp Ravenna, the Block D Igloo 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 C-4
Alternative 2: Land Use Controls - Task 2.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 2.1 Fence and Warning Sign Installation		Total	
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Field Site)						
Construction Manager		$72.26	480	$34,685	480	$34,685
Senior UXO Supervisor (SUXOS)		$85.19	12	$1,022	12	$1,022
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01	4	$368	4	$368
UXO Technician II		$43.98	12	$528	12	$528
UXO Technician II (8% Hazard)		$47.50	4	$190	4	$190
UXO Technician III		$52.71	380	$20,030	380	$20,030
UXO Technician III (OT)		$79.07	96	$7,591	96	$7,591
UXO Technician III (8% Hazard)		$56.93	4	$228	4	$228
TOTAL FIELD SITE LABOR			**992**	**$64,641**	**992**	**$64,641**
TOTAL LABOR			**992**	**$64,641**	**992**	**$64,641**
OTHER DIRECT COSTS	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
Warning signs	each	$15.00	250	$3,750	250	$3,750
Type II Magazine Rental	month	$200.00	1	$200	1	$200
Donor Explosives (purchased for storage)	each	$3,020.65	1	$3,021	1	$3,021
Type II Magazine Delivery/Setup	each	$1,000.00	1	$1,000	1	$1,000
Sandbag, 50-lb, all purpose	each	$2.88	10	$29	10	$29
TOTAL OTHER DIRECT COSTS				**$4,272**		**$4,272**
TRAVEL	Trip	LS	1	**$25,477**		**$25,477**
SUBCONTRACTOR						
6' Tall-Chain Link Fence Installation	linear feet	$28.00	12,215	$342,020	12,215	$342,020
TOTAL SUBCONTRACTOR COSTS				**$342,020**		**$342,020**
TOTAL COSTS				**$436,411**		**$436,411**

ASSUMPTIONS:

Installation of 8-foot high chain link fence around perimeter of MRS (8,715 feet) and both sides of Smalley Road (3,500 feet).

Production rate for fence installation is 250 feet per day (48 work days).

Each workday is 10 hours.

Warning signs will be placed every 50 feet along the length of the fence.

Minimal vegetation removal will be required with the exception of small trees less than 3 inches to properly install the fence.

Table C-5
Alternative 2: Land Use Controls - Task 3.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 3.1 Initial Standard Awareness Training		Subtask 3.2 Training Materials		Total	
		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**
Labor Category (Field Site)								
UXO Technician III		$52.71	24	$1,265			24	$1,265
TOTAL FIELD SITE LABOR			**24**	**$1,265**			**24**	**$1,265**
TOTAL LABOR			**51**	**$4,066**	**22**	**$1,788**	**73**	**$5,853**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (20lbs)	package	$23.00	3	$69			3	$69
Printing	each	$200.00	1	$200			1	$200
TOTAL OTHER DIRECT COSTS				**$269**				**$269**
TRAVEL	Trip	LS	1	**$1,220**				
TOTAL COSTS				**$5,554**		**$1,788**		**$7,342**

ASSUMPTIONS:

The LUCs requirements for the Awareness Standard Training will be incorporated into the Property Management Plan Appendix A which is funded under a separate contract.

Subtask 3.1 includes two travel days and one day of training provided by a UXO Technician for any specific briefings necessary for this MRS and printing of briefing materials.

Subtask 3.2 includes any additional revisions required to handouts or sign-in sheets, specific to the MRS.

Table C-6
Alternative 2: Land Use Controls - Task 4.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 4.1		Subtask 4.2		Total	
			Annual Standard Awareness Training		Annual Inspections			
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Field Site)								
Senior Environmental Engineer		$98.15			8	$785	8	$785.20
Junior Environmental Engineer		$46.43			40	$1,857	40	$1,857.20
UXO Technician III		$52.71	24	$1,265	24	$1,265	48	$2,530
TOTAL FIELD SITE LABOR			**24**	**$1,265**	**72**	**3,907**	**96**	**$5,172**
TOTAL LABOR			**24**	**$1,265**	**72**	**3,907**	**96**	**$5,172**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**			**Quantity**	**Dollars**
FedEx shipments (20lbs)	package	$23.00	3	$69			3	$69
Printing	each	$200.00	1	$200			1	$200
TOTAL OTHER DIRECT COSTS				**$269**				**$269**
TRAVEL	Trip		1	**$1,220**	1	**2,168**		**$3,387**
TOTAL COSTS				**$2,754**		**6,075**		**$8,829**

ASSUMPTIONS:
Subtask 4.1 covers two days of training provided by a UXO Technician for any specific briefings necessary for this MRS, travel costs for the UXO Technician 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 C-7
Alternative 2: Land Use Controls - Task 5.0 Details
RVAAP-060-R-01 Block D Igloo MRS

		Subtask 5.1		Total	
		5-Year Review Report			
	Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)					
Senior Project Manager	$163.06	32	$5,218	32	$5,218
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	32	$1,817	32	$1,817
TOTAL HOME SITE LABOR		**170**	**$17,336**	**170**	**$17,336**
UXO Technician III	$52.71	10	$527	10	$527
TOTAL FIELD SITE LABOR		**10**	**$527**	**10**	**$527**
TOTAL LABOR		**180**	**$17,863**	**180**	**$17,863**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (20lbs)	$23.00	6	$138	6	$138
TOTAL OTHER DIRECT COSTS			**$138**	**6**	**$138**
TOTAL COSTS			**$18,001**		**$18,001**

ASSUMPTIONS:

CERCLA Five-Year Reviews that will occur in Years 5, 10, 15, 20, 25 and 30.

Table C-8
Alternative 2: Land Use Controls - Task 6.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 6.1 Incidental Destruction of MEC		Total	
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Field Site)						
Senior UXO Supervisor (SUXOS)		$85.19	2	$170	2	$170
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01	6	$552	6	$552
UXO Safety Officer (UXOSO)		$85.19	2	$170	2	$170
UXO Safety Officer (UXOSO) (8% Hazard)		$92.01	6	$552	6	$552
UXO Technician II		$43.98	2	$88	2	$88
UXO Technician II (8% Hazard)		$47.50	6	$285	6	$285
TOTAL FIELD SITE LABOR			**24**	**$1,818**	**24**	**$1,818**
TOTAL LABOR			**15**	**$1,818**	**15**	**$1,818**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
Printing	0	$0.00	0	$0	0	$0
EQUIPMENT & MATERIAL COSTS						
Type II Magazine Rental	month	$200.00	0.2	$40	0.2	$40
Donor Explosives (purchased for storage)	each	$3,020.65	0.2	$604	0.2	$604
Type II Magazine Delivery/Setup	each	$1,000.00	0.2	$200	0.2	$200
Sandbag, 50-lb, all purpose	each	$2.88	50	$144	50	$144
TOTAL OTHER DIRECT COSTS				**$988**		**$988**
TRAVEL				**$2,218**		**$2,218**
SUBCONTRACTORS						
Analytical Laboratory				$162		$162
TOTAL SUBCONTRACTORS				**$162**		**$162**
TOTAL COSTS				**$5,186**		**$5,186**

ASSUMPTIONS:

Subtask 6.1 covers the incidental offsite (off the MRS) destruction of any MPPEH confirmed to be MDEH.

It is assumed one item per every 10 years will be located and transported to the Open Demolition Area #2 for destruction.

Travel costs include mobilization/demobilization for SUXOS, the dual-hatted UXOSO/UXOQCS and one UXO Technician II.

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

One 10-hour day, at 8% uplift, is estimated for accepting delivery of explosives and conducting MDEH demolition.

Table C-9
Alternative 3: Surface Removal and LUCs - Cost Summary
RVAAP-060-R-01 Block D Igloo MRS

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Work Plans				
Remedial Action Work Plan	Lump Sum	$57,199	1	$57,199
Explosive Safety Submission	Lump Sum	$10,429	1	$10,429
Remedial Action Report	Lump Sum	$40,592	1	$40,592
Subtotal				**$108,220**
Land Use Control Implementation Plan				
Land Use Control Implementation Plan	Lump Sum	$9,758	1	$9,758
Subtotal				**$9,758**
Mobilization/Demobilization				
Labor and Travel Time	Lump Sum	$9,084	1	$9,084
Airfare/Mileage and Per Diem	Lump Sum	$6,925	1	$6,925
Equipment Mobilization	Lump Sum	$854	1	$854
Subtotal				**$16,863**
Surface and Subsurface Removal				
Surveying and Mapping	Lump Sum	$6,378	1	$6,378
Vegetation Clearing	Acre	$6,508	101.6	$661,217
Instrument-Assisted Visual Survey	Acre	$2,714	101.6	$275,781
MDAS/MDEH Disposal and MC Sampling	Lump Sum	$34,724	1	$34,724
Subtotal				**$978,099**
Siebert Stakes and Warning Sign Installation				
Siebert Stakes and Warning Sign Installation	Lump Sum	$69,657	1	$69,657
Subtotal				**$69,657**
Institutional Controls				
Initial Standard Awareness Training	Lump Sum	$5,554	1	$5,554
Training Materials	Lump Sum	$1,788	1	$1,788
Subtotal				**$7,342**
	SUBTOTAL			**$1,189,939**
	SUPERVISION AND ADMIN @ 8%			$95,195
	CONTINGENCY @ 30%			$356,982
	TOTAL CAPITAL COSTS			**$1,642,116**
ANNUAL O&M COSTS				
Institutional Controls Maintenance				
Annual Standard Awareness Training	Lump Sum	$2,754	30	$82,607
Annual Inspections	Lump Sum	$6,075	30	$182,250
Subtotal				**$264,857**
	SUBTOTAL (ANNUALLY)			**$264,857**
	SUPERVISION AND ADMIN @ 8%			$21,189
	CONTINGENCY @ 30%			$79,457
	TOTAL ANNUAL O&M COSTS (30 Years)			**$365,503**
	O&M PRESENT WORTH (2.8%)			**$245,094**
PERIODIC COSTS				
Incidental Destruction of MDEH (Years 5, 10, 15, 20, 25, 30)				
Incidental Destruction of MDEH	Each	$5,186	6	$31,113
Subtotal				**$31,113**
	SUPERVISION AND ADMIN @ 8%			$2,489
	CONTINGENCY @ 30%			$9,334
	TOTAL PERIODIC COSTS (30 Years)			**$42,936**
	PERIODIC PRESENT WORTH (2.8%)			**$27,224**
TOTAL ALTERNATIVE COST (Capital + O&M Present Worth + Periodic Present Worth)				**$1,914,434**
FIVE-YEAR REVIEWS				
Five Year Reviews (Years 5, 10, 15, 20, 25, 30)				
Five Year Reviews	Each	$18,001	6	$108,007
Subtotal				**$108,007**
	SUPERVISION AND ADMIN @ 8%			$8,641
	CONTINGENCY @ 30%			$32,402
	TOTAL FIVE-YEAR REVIEWS (30 Years)			**$149,049**
	TOTAL FIVE-YEAR REVIEWS PRESENT WORTH (2.8%)			**$94,505**

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 C-10
Alternative 3: Surface Removal and LUCs - Cost Elements
Block D Igloo MRS

TASK	SUBTASK	TASK DESCRIPTION	LABOR HOURS	LABOR DOLLARS	OTHER DIRECT CHARGES	TRAVEL	SUB-CONTRACTORS	SUBTASK TOTAL	TASK TOTAL
1		**Reporting/Work Plans**							**108,220**
	1.1	Remedial Action Work Plan	524	$57,061	$138			$57,199	
	1.2	Explosive Safety Submission	106	$10,429				$10,429	
	1.3	Remedial Action Report	380	$40,454	$138			$40,592	
2		**Surface and Subsurface Removal**							**$994,962**
	2.1	Mobilization/Demobilization	136	$9,084	$854	$6,925		$16,863	
	2.2	Surveying and Mapping	30	$2,638		$740	$3,000	$6,378	
	2.3	Vegetation Clearing	6,320	$397,888	$227,670	$35,658		$661,217	
	2.4	Instrument-Assisted Visual Survey	1,576	$121,408	$126,135	$28,238		$275,781	
	2.5	MDAS/MDEH Disposal and MC Sampling	176	$14,513	$3,469	$10,741	$6,000	$34,724	
3		**Siebert Stakes and Warning Sign Installation**							**$69,657**
	3.1	Siebert Stakes and Warning Sign Installation	786	$40,678	$6,875	$22,104		$69,657	
4		**Land Use Control Implementation Plan**							**$9,758**
	4.1	Land Use Control Implementation Plan	90	$9,620	$138			$9,758	
5		**Institutional Controls**							**$7,342**
	5.1	Initial Standard Awareness Training	51	$4,066	$269	$1,220		$5,554	
	5.2	Training Materials	22	$1,788				$1,788	
6		**Institutional Controls Maintenance**							**$8,829**
	6.1	Annual Standard Awareness Training	24	$1,265	$269	$1,220		$2,754	
	6.2	Annual Inspections	72	$3,907		$2,168		$6,075	
7		**Five-Year Reviews**							**$18,001**
	7.1	5-Year Review Report	180	$17,863	$138			$18,001	
8		**Incidental Destruction of MDEH**							**$5,186**
	8.1	Incidental Destruction of MDEH	24	$1,818	$988	$2,218	$162	$5,186	
		TOTAL	**9,248**	**$653,475**	**$358,405**	**$82,302**	**$9,000**		

[1]Costs for Tasks 4 through 7 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 C-11
Alternative 3: Surface Removal and LUCs - Task 1.0 Details
RVAAP-060-R-01 Block D Igloo MRS

		Subtask 1.1		Subtask 1.2		Subtask 1.3		Total	
		Remedial Action Work Plan		Explosive Safety Submission		Remedial Action Completion Report			
	Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)									
Corporate Quality Manager	$163.06	8	$1,304	4	$652	8	$1,304	20	$3,261
Senior Project Manager	$163.06	60	$9,784	24	$3,913	48	$7,827	132	$21,524
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	10	$1,025	24	$2,460	58	$5,944
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	48	$3,703	100	$7,714	268	$20,674
Administrative Assistant	$56.79	32	$1,817	20	$1,136	32	$1,817	84	$4,770
TOTAL HOME SITE LABOR		**524**	**$57,061**	**106**	**$10,429**	**380**	**$40,454**	**1,010**	**$107,944**
TOTAL LABOR		**524**	**$57,061**	**106**	**$10,429**	**380**	**$40,454**	**1,010**	**$107,944**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (20lbs)	$23.00	6	$138			6	$138	12	$276
TOTAL OTHER DIRECT COSTS			**$138**				**$138**		**$276**
TOTAL COSTS			**$57,199**		**$10,429**		**$40,592**		**$108,220**

Table C-12
Alternative 3: Surface Removal and LUCs - Task 2.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 2.1		Subtask 2.2		Subtask 2.3		Subtask 2.4		Subtask 2.5		Total	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Clearing		Instrument-Assisted Visual Survey		MDAS/MDEH Disposal and MC Sampling			
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)														
Senior Project Manager		$163.06	8	$1,304			8		8	$1,304	8	1,304	32	$3,913
Senior Geophysicist		$163.06												
Junior Geophysicist		$102.49	16	$1,640					250	$25,623			266	$27,262
Senior Chemist		$163.06									8	1,304	8	$1,304
Junior Chemist		$77.14									16	1,234	16	$1,234
Junior Geologist		$77.14												
Administrative Assistant		$56.79					12	$681	18	$1,022	24	1,363	54	$3,067
TOTAL HOME SITE LABOR			**24**	**$2,944**			**20**	**$681**	**276**	**$27,949**	**56**	**$5,206**	**376**	**$36,781**
Senior UXO Supervisor (SUXOS)		$85.19	16	$1,363	6	$511	24	$2,045	8	$682			54	$4,600
Senior UXO Supervisor (SUXOS) (OT)		$127.79					6	$767	2	$256			8	$1,022
Senior UXO Supervisor (SUXOS) (4% Hazard)		$88.60			24	$2,126	816	$72,298			40	$3,544	880	$77,968
Senior UXO Supervisor (SUXOS) (4% Hazard) (OT)		$132.90					204	$27,112					204	$27,112
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01							200	$18,402			200	$18,402
Senior UXO Supervisor (SUXOS) (8% Hazard) (OT)		$138.02							50	$6,901			50	$6,901
UXO Safety Officer (UXOSO)		$85.19	16	$1,363			24	$2,045	8	$682	40	$3,408	88	$7,497
UXO Safety Officer (UXOSO) (OT)		$127.79					6	$767	2	$256			8	$1,022
UXO Safety Officer (UXOSO) (4% Hazard)		$88.60					816	$72,298					816	$72,298
UXO Safety Officer (UXOSO) (4% Hazard) (OT)		$132.90					204	$27,112					204	$27,112
UXO Safety Officer (UXOSO) (8% Hazard)		$92.01							200	$18,402			200	$18,402
UXO Safety Officer (UXOSO) (8% Hazard) (OT)		$138.02							50	$6,901			50	$6,901
UXO Technician I **		$36.35	32	$1,163			48	$1,745	8	$291			88	$3,199
UXO Technician I (OT)		$54.53					12	$654	2	$109			14	$763
UXO Technician I (4% Hazard)		$37.80					1,632	$61,690					1,632	$61,690
UXO Technician I (4% Hazard) (OT)		$56.70					408	$23,134					408	$23,134
UXO Technician I (8% Hazard)		$39.26							200	$7,852			200	$7,852
UXO Technician I (8% Hazard) (OT)		$58.89							50	$2,945	40	$2,356	90	$5,300
UXO Technician II		$43.98	32	$1,407			48	$2,111	8	$352			88	$3,870
UXO Technician II (OT)		$65.97					12	$792	2	$132			14	$924
UXO Technician II (4% Hazard)		$45.74					1,632	$74,648					1,632	$74,648
UXO Technician II (4% Hazard) (OT)		$68.61					408	$27,993					408	$27,993
UXO Technician II (8% Hazard)		$47.50							200	$9,500			200	$9,500
UXO Technician II (8% Hazard) (OT)		$71.25							50	$3,563			50	$3,563
UXO Technician III		$52.71	16	$843					8	$422			24	$1,265
UXO Technician III (OT)		$79.07							2	$158			2	$158
UXO Technician III (4% Hazard)		$54.82												
UXO Technician III (4% Hazard) (OT)		$82.23												
UXO Technician III (8% Hazard)		$56.93							200	$11,386			200	$11,386
UXO Technician III (8% Hazard) (OT)		$85.40							50	$4,270			50	$4,270
** SCA WD (Site Specific) Utilized														
TOTAL FIELD SITE LABOR			**112**	**$6,140**	**30**	**$2,638**	**6,300**	**$397,207**	**1,300**	**$93,459**	**120**	**$9,307**	**7,862**	**$508,750**
TOTAL LABOR			**136**	**$9,084**	**30**	**$2,638**	**6,320**	**$397,888**	**1,576**	**$121,408**	**176**	**$14,513**	**8,238**	**$545,531**

Table C-12
Alternative 3: Surface Removal and LUCs - Task 2.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 2.1		Subtask 2.2		Subtask 2.3		Subtask 2.4		Subtask 2.5		Total	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Clearing		Instrument-Assisted Visual Survey		MDAS/MDEH Disposal and MC Sampling			
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (20lbs)	package	$23							12	$276	3.00	$69	15	$345
Printing	each	$200									2.00	$400	2	$400
EQUIPMENT AND MATERIALS														
Trailer rental	week	$500					21	$10,500	11	$5,500			32	$16,000
explosives	shot	$3,000									1	$3,000	1	$3,000
GPS Rover	week	$900							11	$9,900			11	$9,900
UTV rental	week	$1,500					42	$63,000	22	$33,000			64	$96,000
Misc. equipment	month	$3,000					5	$15,000	2	$6,000			7	$21,000
Pickup truck rental	day	$104					210	$21,840	110	$11,440			320	$33,280
Pickup truck FOGM	hour	$50					1,680	$84,000	880	$44,000			2,560	$128,000
Office Trailer mobilization	lump sum	$800	1	$800									1	$800
Office trailer rental	month	$3,000					5	$15,000	2	$6,000			7	$21,000
Generator rental	week	$200					21	$4,200	11	$2,200			32	$6,400
RVAAP seed mix	acres	$300												
Sales Tax	6.75%			$54				$14,130		$7,819				$22,004
TOTAL OTHER DIRECT COSTS				**$854**				**$227,670**		**$126,135**		**$3,469**		**$358,129**
TRAVEL				**$6,925**		**$740**		**$35,658**		**$28,238**		**$10,741**		**$82,302**
SUBCONTRACTORS:														
Surveyor						$3,000								$3,000
MDAS Transportation	lump sum	$2,000									1	$2,000		
MDAS Disposal	ton	$800									5	$4,000		$4,000
Analytical Laboratory	sample	$135									6	$810		
TOTAL SUBCONTRACTORS						**$3,000**						**$6,000**		**$9,000**
TOTAL COSTS				**$16,863**		**$6,378**		**$661,217**		**$275,781**		**$34,724**		**$994,962**

Table C-13
Alternative 3: Surface Removal and LUCs - Basis of Estimate
RVAAP-060-R-01 Block D Igloo MRS

2.1 Mobilization/Demobilization

Mobilization/demoblization includes 2 eight-hour days for travel to and from the site. One Project Manager site visit is included during the duration of the field work event. Staff mobilizations required include: SUXOS, UXOSO/UXOQCS (dual-hatted), 2 UXO Technicians Is, 2 UXO Technician IIs, 1 UXO Technician IIIs, 1 Junior Geophysicist. Eight field personnel plus the Project Manager = 9 mobilizations/demobilizations.

2.2 Surveying and Mapping

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

2.3 Vegetation Clearing

Labor hours include Project Manager hours for supervision, Administrative staff support for procurement tasks. Each subtask workday is 10 hours. Subtask assumes a production rate of 1 acre per day for vegetation removal (102 workdays). Setup and safety briefings for the subcontractor is estimated for 0.5-day. Three (3) additional days are estimated for site restoration and equipment maintenance. Field labor include the SUXOS, UXOSO, 2 UXO Technican Is, and 2 UXO Technician IIs. No UXOQCS is required for brush clearance tasks only.

2.4 Instrument-Assisted Visual Survey

Labor hours include Project Manager hours for supervision and Administrative staff support for procurement tasks. Each subtask workday is 10 hours. Subtask assumes a production rate of 4 acres per day for visual survey activities (25 workdays). Geophysical equipment setup, personnel safety briefings, and instrument verification strip equipment checks are estimated for 4-days. Field labor includes the SUXOS, the UXOSO/UXOQCS (dual-hatted), 1 Junior Geophysicist, a UXO Technician I, a UXO Technician II, and a UXO Technician III. Surface removal of MPPEH/MDEH to be conducted concurrently with the visual survey.

Table C-13
Alternative 3: Surface Removal and LUCs - Basis of Estimate
RVAAP-060-R-01 Block D Igloo MRS

2.5 MDAS/MDEH Disposal and MC Sampling

Labor hours include Project Manager hours for supervision and Administrative staff support for procurement tasks. Field labor includes the SUXOS, UXOSO/UXOQCS (dual-hatted), and UXO Technician II. Subtask duration is 5 eight-hour days to conduct demolition of incidental MDEH and package and shipping of MDAS for offsite flashing and recycling. It is assumed that all MDEH can be transported offsite for consolidated detonation at Open Demolition Area #2. One demolition event is assumed (maximum net explosive weight of 25 lbs) for destruction of incidential MDEH during construction activities. Sampling for MC includes 6 ISM samples (3 pre-demolition samples and 3 post-demolition samples including QC for each event) to be analyzed for explosives for each event. A total of 5 tons of MDAS is assumed for off-site disposal for recycling.

DGM denotes digital geophysical mapping
ISM denotes incremental sampling methodology
MC denotes munitions constitutents
MDAS denotes material documented as safe
MDEH denotes material documented as an explosive hazard

Table C-14
Alternative 3: Surface Removal and LUCs - Task 3.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 3.1 Siebert Stakes and Warning Sign Installation		Total	
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Field Site)						
Construction Manager		$72.26	150	$10,839	150	$10,839
Heavy Equipment Operator		$36.67	360	$13,201	360	$13,201
Heavy Equipment Operator (OT)		$55.01	90	$4,951	90	$4,951
Senior UXO Supervisor (SUXOS)		$85.19	12	$1,022	12	$1,022
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01	4	$368	4	$368
UXO Technician II		$43.98	12	$528	12	$528
UXO Technician II (8% Hazard)		$47.50	4	$190	4	$190
UXO Technician III		$52.71	100	$5,271	100	$5,271
UXO Technician III (8% Hazard)		$56.93	4	$228	4	$228
UXO Technician III (8% Hazard) (OT)		$85.40	20	$1,708	20	$1,708
TOTAL FIELD SITE LABOR			**786**	**$40,678**	**786**	**$40,678**
TOTAL LABOR			**786**	**$40,678**	**786**	**$40,678**
OTHER DIRECT COSTS	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
Seibert Stake	each	$21.13	125	$2,641	125	$2,641
T-post (7 ft)	each	$5.29	250	$1,323	250	$1,323
Pneumatic post driver	week	$175.00	2	$350	2	$350
Warning signs	each	$15.00	125	$1,875	125	$1,875
Type II Magazine Rental	month	$200.00	1	$200	1	$200
Donor Explosives (purchased for storage)	each	$3,020.65	1	$3,021	1	$3,021
Type II Magazine Delivery/Setup	each	$1,000.00	1	$1,000	1	$1,000
Sandbag, 50-lb, all purpose	each	$2.88	10	$29	10	$29
TOTAL OTHER DIRECT COSTS				**$6,875**		**$6,875**
TRAVEL	Trip	LS	1	**$22,104**		**$22,104**
TOTAL COSTS				**$69,657**		**$69,657**

ASSUMPTIONS:

Installation of Siebert stakes and signs around perimeter of MRS (8,715 feet) and both sides of Smalley Road (3,500 feet).

Production rate for post installation is 25 per days (10 work days) and one week for placement of Siebert markers and signs (5 work days).

Siebert markers and warning signs to be alternately placed every 50 feet.

Minimal vegetation removal will be required with the exception of small trees less than 3 inches to properly install the posts.

Table C-15
Alternative 3: Surface Removal and LUCs - Task 4.0 Details
RVAAP-060-R-01 Block D Igloo MRS

		Subtask 4.1 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 (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 Block D Igloo MRS LUCs will document inclusion of the MRS in the current procedures for LUC Awareness Training already implemented by Camp Ravenna.

The updated Appendix A in 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 C-16
Alternative 3: Surface Removal and LUCs - Task 5.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 5.1 Initial Standard Awareness Training		Subtask 5.2 Training Materials		Total	
		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**
Labor Category (Field Site)								
UXO Technician III		$52.71	24	$1,265			24	$1,265
TOTAL FIELD SITE LABOR			**24**	**$1,265**			**24**	**$1,265**
TOTAL LABOR			**51**	**$4,066**	**22**	**$1,788**	**73**	**$5,853**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (20lbs)	package	$23.00	3	$69			3	$69
Printing	each	$200.00	1	$200			1	$200
TOTAL OTHER DIRECT COSTS				**$269**				**$269**
TRAVEL	Trip	LS	1	**$1,220**				
TOTAL COSTS				**$5,554**		**$1,788**		**$7,342**

ASSUMPTIONS:

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

Subtask 5.1, will include any revisions required for specific materials related to the Block D Igloo MRS or updates to the Property Management Plan materials.

Subtask 5.2, Training materials will include any additional revisions required to handouts or sign-in sheets, specific to the Block D Igloo MRS.

Table C-17
Alternative 3: Surface Removal and LUCs - Task 6.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 6.1		Subtask 6.2		Total	
			Annual Standard Awareness Training		Annual Inspections			
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Senior Environmental Engineer		$98.15			8	$785	8.00	$785.20
Junior Environmental Engineer		$46.43			40	$1,857	40.00	$1,857.20
UXO Technician III		$52.71	24	$1,265	24	$1,265	48	$2,530
TOTAL FIELD SITE LABOR			**24**	**$1,265**	**72**	**$3,907**	**96**	**$5,172**
TOTAL LABOR			**24**	**$1,265**	**72**	**$3,907**	**96**	**$5,172**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**			**Quantity**	**Dollars**
FedEx shipments (20lbs)	package	$23.00	3	$69			3	$69
Printing	each	$200.00	1	$200			1	$200
TOTAL OTHER DIRECT COSTS				**$269**				**$269**
TRAVEL	Trips	LS	1	**$1,220**	1	**$2,168**		**$3,387**
TOTAL COSTS				**$2,754**		**$6,075**		**$8,829**

ASSUMPTIONS:

Subtask 6.1 includes two travel days and one day of training provided by a UXO Technician for any specific briefings necessary for this MRS, travel costs for the UXO Technician to mobilize, and printing of briefing materials.

The original version of the Standard Awareness Training materials will be developed as part of the Property Management Plan Appendix A which is funded under a separate contract with updates created in Subtask 1 and Subtask 2. These costs are for future annual training events.

Subtask 6.2. includes two days travel and one day of inspection by a UXO Technician and a Junior Level Engineer for each annual inspection event at the MRS, and two days for preparation and submission of the Inspection Log

Table C-18
Alternative 3: Surface Removal and LUCs - Task 7.0 Details
RVAAP-060-R-01 Block D Igloo MRS

		Subtask 7.1		Total	
		5-Year Review Report			
	Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)					
Senior Project Manager	$163.06	32	$5,218	32	$5,218
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	32	$1,817	32	$1,817
TOTAL HOME SITE LABOR		**170**	**$17,336**	**170**	**$17,336**
UXO Technician III	$52.71	10	$527	10	$527
TOTAL FIELD SITE LABOR		**10**	**$527**	**10**	**$527**
TOTAL LABOR		**180**	**$17,863**	**180**	**$17,863**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (20lbs)	$23.00	6	$138	6	$138
TOTAL OTHER DIRECT COSTS			**$138**		**$138**
TOTAL COSTS			**$18,001**		**$18,001**

ASSUMPTIONS:

CERCLA Five-Year Reviews that will occur in Years 5, 10, 15, 20, 25, and 30.

Table C-19
Alternative 3: Surface Removal and LUCs - Task 8.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 8.1 Incidental Destruction of MDEH		Total	
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Field Site)						
Senior UXO Supervisor (SUXOS)		$85.19	2	$170	2	$170
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01	6	$552	6	$552
UXO Safety Officer (UXOSO)		$85.19	2	$170	2	$170
UXO Safety Officer (UXOSO) (8% Hazard)		$92.01	6	$552	6	$552
UXO Technician II		$43.98	2	$88	2	$88
UXO Technician II (8% Hazard)		$47.50	6	$285	6	$285
TOTAL FIELD SITE LABOR			**24**	**$1,818**	**24**	**$1,818**
TOTAL LABOR			**24**	**$1,818**	**24**	**$1,818**
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
Printing	0	$0.00	0	$0	0	$0
EQUIPMENT & MATERIAL COSTS						
Type II Magazine Rental	month	$200.00	0.2	$40	0	$40
Donor Explosives (purchased for storage)	each	$3,020.65	0.2	$604	0	$604
Type II Magazine Delivery/Setup	each	$1,000.00	0.2	$200	0	$200
Sandbag, 50-lb, all purpose	each	$2.88	50	$144	50	$144
TOTAL OTHER DIRECT COSTS				**$988**		**$988**
TRAVEL				**$2,218**		**$2,218**
SUBCONTRACTORS:						
Analytical Laboratory				$162		$162
TOTAL SUBCONTRACTORS				**$162**		**$162**
TOTAL COSTS				**$5,186**		**$5,186**

ASSUMPTIONS:

Subtask 8.1 covers the incidental offsite (off the MRS) destruction of any MPPEH confirmed to be MDEH. It is assumed one item per every 5 years will be located and transported to the Open Demolition Area #2 for destruction.

Travel costs for the demolition team (SUXOS, the dual-hatted UXOSO/UXOQCS and one UXO Technician II) to mobilize/demobilize are included.

One 10-hour day, at 8% uplift, is estimated for accepting delivery of explosives and conducting MDEH demolition.

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

Table C-20
Alternative 4: Surface and Subsurface Removal (UU/UE) - Cost Summary
RVAAP-060-R-01 Block D Igloo MRS

ITEM	UNIT	UNIT COST	QUANTITY	TOTAL
CAPITAL COSTS				
Reporting/Workplans				
Remedial Action Work Plan	Lump Sum	$57,199	1	$57,199
Explosive Safety Submission	Lump Sum	$10,429	1	$10,429
Remedial Action Report	Lump Sum	$40,592	1	$40,592
Subtotal				**$108,220**
Mobilization/Demobilization				
Labor and Travel Time	Lump Sum	$10,724	1	$10,724
Airfare/Mileage and Per Diem	Lump Sum	$9,766	1	$9,766
Equipment Mobilization	Lump Sum	$2,455	1	$2,455
Subtotal				**$22,945**
Surface and Subsurface Removal				
Surveying and Mapping	Lump Sum	$6,378	1	$6,378
Vegetation Clearing	Acre	$6,508	101.6	$661,217
Digital Geophysical Mapping	Acre	$4,580	101.6	$465,353
Anomaly Reacquire and MPPEH/MDEH Removal	Acre	$37,115	101.6	$3,770,865
MDAS/MDEH Disposal and MC Sampling	Lump Sum	$65,917	1	$65,917
Subtotal				**$4,969,730**
	SUBTOTAL			**$5,100,895**
	SUPERVISION AND ADMIN @ 8%			$408,072
	CONTINGENCY @ 30%			$1,530,268
	TOTAL CAPITAL COSTS			**$7,039,235**
TOTAL ALTERNATIVE COST				**$7,039,235**

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 C-21
Alternative 4: Surface and Subsurface Removal (UU/UE) - Cost Elements
RVAAP-060-R-01 Block D Igloo MRS

TASK	SUBTASK	TASK DESCRIPTION	LABOR HOURS	LABOR DOLLARS	OTHER DIRECT CHARGES	TRAVEL	SUB-CONTRACTORS	SUBTASK TOTAL	TASK TOTAL
1		**Work Plans**							**108,220**
	1.1	Remedial Action Work Plan	524	$57,061	$138			$57,199	
	1.2	Explosive Safety Submission	106	$10,429				$10,429	
	1.3	Remedial Action Report	380	$40,454	$138			$40,592	
2		**Remedial Action: Surface and Subsurface Removal**							**$4,992,675**
	2.1	Mobilization/Demobilization	152	$10,724	$2,455	$9,766		$22,945	
	2.2	Surveying and Mapping	30	$2,638		$740	$3,000	$6,378	
	2.3	Vegetation Clearing	6,320	$397,888	$227,670	$35,658		$661,217	
	2.4	Digital Geophysical Mapping	3,414	$286,721	$143,749	$34,883		$465,353	
	2.5	Anomaly Reacquire and MPPEH/MDEH Removal	37,248	$2,763,127	$907,072	$100,666		$3,770,865	
	2.6	MDAS/MDEH Disposal and MC Sampling	394	$34,989	$9,469	$3,459	$18,000	$65,917	
		TOTAL	**48,568**	**$3,604,031**	**$1,290,692**	**$185,172**	**$21,000**		

[1]Costs are not discounted.

Table C-22
Alternative 4: Surface and Subsurface Removal (UU/UE) - Task 1.0 Details
RVAAP-060-R-01 Block D Igloo MRS

		Subtask 1.1 Remedial Action Work Plan		Subtask 1.2 Explosive Safety Submission		Subtask 1.3 Remedial Action Completion Report		Total	
	Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)									
Corporate Quality Manager	$163.06	8	$1,304	4	$652	8	$1,304	20	$3,261
Senior Project Manager	$163.06	60	$9,784	24	$3,913	48	$7,827	132	$21,524
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	10	$1,025	24	$2,460	58	$5,944
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	48	$3,703	100	$7,714	268	$20,674
Administrative Assistant	$56.79	32	$1,817	20	$1,136	32	$1,817	84	$4,770
TOTAL HOME SITE LABOR		**524**	**$57,061**	**106**	**$10,429**	**380**	**$40,454**	**1,010**	**$107,944**
TOTAL LABOR		**524**	**$57,061**	**106**	**$10,429**	**380**	**$40,454**	**1,010**	**$107,944**
OTHER DIRECT COSTS:	**Rate**	**Quantity**	**Dollars**	**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**		**$10,429**		**$40,592**		**$108,220**

Table C-23
Alternative 4: Surface and Subsurface Removal (UU/UE) - Task 2.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 2.1		Subtask 2.2		Subtask 2.3		Subtask 2.4		Subtask 2.5		Subtask 2.6		Total	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Clearing		Digital Geophysical Mapping		Anomaly Reacquire and MPPEH/MDEH Removal		MDAS/MDEH Disposal and MC Sampling			
		Project Rate	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars	Hours/Qty	Dollars
Labor Category (Home Site)																
Senior Project Manager		$163.06	8	$1,304			8		8	$1,304	8	$1,304	10	1,631	42	$5,544
Senior Geophysicist		$163.06							88	$14,349	328	$53,484			416	$67,833
Junior Geophysicist		$102.49	32	$3,280					1,100	$112,739	8,200	$840,418			9,332	$956,437
Senior Chemist		$163.06											48	7,827	48	$7,827
Junior Chemist		$77.14											30	2,314	30	$2,314
Junior Geologist		$77.14											42	3,240	42	$3,240
Administrative Assistant		$56.79					12	$681	18	$1,022	12		24	1,363	66	$3,067
TOTAL HOME SITE LABOR			**40**	**$4,584**			**20**	**$681**	**1,214**	**$129,415**	**8,548**	**$895,206**	**154**	**$16,375**	**9,976**	**$1,046,261**
Senior UXO Supervisor (SUXOS)		$85.19	16	$1,363	6	$511	24	$2,045	32	$2,726	32	$2,726			110	$9,371
Senior UXO Supervisor (SUXOS) (OT)		$127.79					6	$767	8	$1,022	8	$1,022			22	$2,811
Senior UXO Supervisor (SUXOS) (4% Hazard)		$88.60			24	$2,126	816	$72,298	408	$36,149			80	$7,088	1,328	$117,661
Senior UXO Supervisor (SUXOS) (4% Hazard) (OT)		$132.90					204	$27,112	102	$13,556					306	$40,667
Senior UXO Supervisor (SUXOS) (8% Hazard)		$92.01									3,248	$298,848			3,248	$298,848
Senior UXO Supervisor (SUXOS) (8% Hazard) (OT)		$138.02									812	$112,072			812	$112,072
UXO Safety Officer (UXOSO)		$85.19	16	$1,363			24	$2,045	32	$2,726	32	$2,726	80	$6,815	184	$15,675
UXO Safety Officer (UXOSO) (OT)		$127.79					6	$767	8	$1,022	8	$1,022			22	$2,811
UXO Safety Officer (UXOSO) (4% Hazard)		$88.60					816	$72,298	408	$36,149					1,224	$108,446
UXO Safety Officer (UXOSO) (4% Hazard) (OT)		$132.90					204	$27,112	102	$13,556					306	$40,667
UXO Safety Officer (UXOSO) (8% Hazard)		$92.01									3,248	$298,848			3,248	$298,848
UXO Safety Officer (UXOSO) (8% Hazard) (OT)		$138.02									812	$112,072			812	$112,072
UXO Technician I **		$36.35	32	$1,163			48	$1,745	32	$1,163	64	$2,326			176	$6,398
UXO Technician I (OT)		$54.53					12	$654	8	$436	16	$872			36	$1,963
UXO Technician I (4% Hazard)		$37.80					1,632	$61,690	408	$15,422					2,040	$77,112
UXO Technician I (4% Hazard) (OT)		$56.70					408	$23,134	102	$5,783					510	$28,917
UXO Technician I (8% Hazard)		$39.26									6,496	$255,033			6,496	$255,033
UXO Technician I (8% Hazard) (OT)		$58.89									1,624	$95,637	80	$4,711	1,704	$100,349
UXO Technician II **		$43.98	32	$1,407			48	$2,111	32	$1,407	64	$2,815			176	$7,740
UXO Technician II (OT)		$65.97					12	$792	8	$528	16	$1,056			36	$2,375
UXO Technician II (4% Hazard)		$45.74					1,632	$74,648	408	$18,662					2,040	$93,310
UXO Technician II (4% Hazard) (OT)		$68.61					408	$27,993	102	$6,998					510	$34,991
UXO Technician II (8% Hazard)		$47.50									6,496	$308,560			6,496	$308,560
UXO Technician II (8% Hazard) (OT)		$71.25									1,624	$115,710			1,624	$115,710
UXO Technician III **		$52.71	16	$843							32	$1,687			48	$2,530
UXO Technician III (OT)		$79.07									8	$633			8	$633
UXO Technician III (4% Hazard)		$54.82														
UXO Technician III (4% Hazard) (OT)		$82.23														
UXO Technician III (8% Hazard)		$56.93									3,248	$184,909			3,248	$184,909
UXO Technician III (8% Hazard) (OT)		$85.40									812	$69,345			812	$69,345
** SCA WD (Site Specific) Utilized																
TOTAL FIELD SITE LABOR			**112**	**$6,140**	**30**	**$2,638**	**6,300**	**$397,207**	**2,200**	**$157,307**	**28,700**	**$1,867,920**	**240**	**$18,614**	**37,582**	**$2,449,825**
TOTAL LABOR			**152**	**$10,724**	**30**	**$2,638**	**6,320**	**$397,888**	**3,414**	**$286,721**	**37,248**	**$2,763,127**	**394**	**$34,989**	**47,558**	**$3,496,087**

Table C-23
Alternative 4: Surface and Subsurface Removal (UU/UE) - Task 2.0 Details
RVAAP-060-R-01 Block D Igloo MRS

			Subtask 2.1		Subtask 2.2		Subtask 2.3		Subtask 2.4		Subtask 2.5		Subtask 2.6		Total	
			Mobilization/Demobilization		Surveying and Mapping		Vegetation Clearing		Digital Geophysical Mapping		Anomaly Reacquire and MPPEH/MDEH Removal		MDAS/MDEH Disposal and MC Sampling			
OTHER DIRECT COSTS:	**Unit of Measure**	**Rate**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**	**Quantity**	**Dollars**
FedEx shipments (Reston to Baltimore, 20lbs)	package	$23							12	$276	1	$23	3.00	$69	16	$368
Printing	each	$200											2.00	$400	2	$400
EQUIPMENT AND MATERIALS																
Trailer rental	week	$500					21	$10,500	11	$5,500	82	$41,000			114	$57,000
explosives	shot	$3,000											3	$9,000	3	$9,000
DGM equipment mobilization	lump sum	$1,500	1	$1,500											1	$1,500
EM61 rental	week	$1,500							11	$16,500					11	$16,500
GPS Rover	week	$900							11	$9,900					11	$9,900
UTV rental	week	$1,500					42	$63,000	22	$33,000	164	$246,000			228	$342,000
Misc. equipment	month	$3,000					5	$15,000	2	$6,000	20	$60,000			27	$81,000
Pickup truck rental	day	$104					210	$21,840	110	$11,440	820	$85,280			1,140	$118,560
Pickup truck FOGM	hour	$50					1,680	$84,000	880	$44,000	6,560	$328,000			9,120	$456,000
Office Trailer mobilization	lump sum	$800	1	$800											1	$800
Office trailer rental	month	$3,000					5	$15,000	2	$6,000	20	$60,000			27	$81,000
Generator rental	week	$200					21	$4,200	11	$2,200	82	$16,400			114	$22,800
RVAAP seed mix	acres	$300									50	$15,000			50	$15,000
Sales Tax	6.75%			$155				$14,130		$8,933		$55,369				$78,588
TOTAL OTHER DIRECT COSTS				**$2,455**				**$227,670**		**$143,749**		**$907,072**		**$9,469**		**$1,290,416**
TRAVEL				**$9,766**		**$740**		**$35,658**		**$34,883**		**$100,666**		**$3,459**		**$185,172**
SUBCONTRACTORS:																
Surveyor						$3,000										$3,000
MDAS Transportation	lump sum	$2,000											1	$2,000		
MDAS Disposal	ton	$800											20	$16,000		$16,000
Analytical Laboratory	sample	$135											18	$2,430		
TOTAL SUBCONTRACTORS						**$3,000**								**$18,000**		**$21,000**
TOTAL COSTS				**$22,945**		**$6,378**		**$661,217**		**$465,353**		**$3,770,865**		**$65,917**		**$4,992,675**

Table C-24
Alternative 4: Surface and Subsurface Removal (UU/UE) - Basis of Estimate
RVAAP-060-R-01 Block D Igloo MRS

2.1 Mobilization/Demobilization

Mobilization/demoblization includes 2 eight-hour days for travel to and from the site. One Project Manager site visit is included during the duration of the field work event. Staff mobilizations required include: SUXOS, UXOSO/UXOQCS (dual-hatted), 2 UXO Technicians Is, 2 UXO Technician IIs, 1 UXO Technician IIIs, 1 Senior Geophysicist, 1 Junior Geophysicist. Nine field personnel plus the Project Manager = 10 mobilizations/demobilizations.

2.2 Surveying and Mapping

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

2.3 Vegetation Removal

Labor hours include Project Manager hours for supervision, Administrative staff support for procurement tasks. Each subtask workday is 10 hours. Subtask assumes a production rate of 1 acre per day for vegetation removal (102 workdays). Setup and safety briefings for the subcontractor is estimated for 0.5-day. Three (3) additional days are estimated for site restoration and equipment maintenance. Field labor include the SUXOS, UXOSO, 2 UXO Technican Is, and 2 UXO Technician IIs. No UXOQCS is required for brush clearance tasks only.

2.4 Digitial Geophysical Mapping

Labor hours include Project Manager hours for supervision and Administrative staff support for procurement tasks. Each subtask workday is 10 hours. Subtask assumes a production rate of 2 acres per day for DGM activities (51 workdays). Geophysical equipment setup, personnel safety briefings, and instrument verification strip equipment checks are estimated for 4-days. Field labor includes the SUXOS, the UXOSO/UXOQCS (dual-hatted), 1 Senior Geophysicist (includes his data processing hours occuring in the office), 2 Junior Geophysicists, a UXO Technician I and UXO Technician II.

Table C-24
Alternative 4: Surface and Subsurface Removal (UU/UE) - Basis of Estimate
RVAAP-060-R-01 Block D Igloo MRS

2.5 Anomaly Reacquire and MPPEH/MDEH Removal

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 0.25 acres per day for anomaly reacquisition and MPPEH/MDEH removal (410 days). Field labor includes the SUXOS, the UXOSO/UXOQCS (dual-hatted) and two dig teams consisting of 2 UXO Technician Is, 2 UXO Technician IIs, and a UXO Technician III, Senior Geophysicist (data processing), and 2 Junior Geophysicists.

2.6 MDAS/MDEH Disposal and MC Sampling

Labor hours include Project Manager hours for supervision and Administrative staff support for procurement tasks. Field labor includes the SUXOS, UXOSO/UXOQCS (dual-hatted), and UXO Technician II. Subtask duration is 10 eight-hour days to conduct demolition of incidental MDEH and package and shipping of MDAS for offsite flashing and recycling. It is assumed that all MDEH can be transported offsite for consolidated detonation at Open Demolition Area #2. Three demolition events are assumed (one each for combined net explosive weight of 25 lbs) for destruction of incidential MDEH during construction activities. Sampling for MC includes 6 ISM samples (3 pre-demolition samples and 3 post-demolition samples including QC for each event) to be analyzed for explosives for each event. A total of 20 tons of MDAS is assumed for off-site disposal for recycling.

DGM denotes digital geophysical mapping
ISM denotes incremental sampling methodology
MC denotes munitions constitutents
MDAS denotes material documented as safe
MDEH denotes material documented as an explosive hazard