FINAL, REVISION 1
FEASIBILITY STUDY
RANGE COMPLEX 1, RANGE COMPLEX 2, ARMY NATIONAL GUARD AND FLAME THROWER RANGE MUNITIONS RESPONSE SITES
FORMER CAMP BUTNER
GRANVILLE, PERSON, AND DURHAM COUNTIES, NORTH CAROLINA

Prepared for:

U.S. Army Corps of Engineers
U.S. Army Engineering and Support Center, Huntsville

Contract No. W912DY-10-D-0023
Delivery Order No. 0009
FUDS Project No. I04NC00902

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

AGC	advanced geophysical classification
ARAR	applicable or relevant and appropriate requirement
ARNG	Army National Guard
bgs	below ground surface
BIP	blow-in-place
CDC	contained detonation chambers
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DERP	Defense Environmental Restoration Program
DGM	digital geophysical mapping
DoD	U.S. Department of Defense
EMI	Electromagnetic Induction
ESTCP	Environmental Security Technology Certification Program
FDEMI	frequency domain electromagnetic induction
FRTR	Federal Remediation Technologies Roundtable
FS	feasibility study
ft	foot, feet
FTR	Flame Thrower Range
FUDS	Formerly Used Defense Site
FUDSMIS	Formerly Used Defense Sites Management Information System
GPR	ground penetrating radar
GPS	Global Positioning System
GRA	general response action
HA	Hazard Assessment
HE	high explosives
HGL	HydroGeoLogic, Inc.
HGR	Hand Grenade Range
Hz	hertz
IC	institutional control
ISM	incremental sampling methodology
LUC	Land Use Control
MC	munitions constituent
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern

mm	millimeter
MPPEH	material potentially presenting an explosives hazard
MRS	munitions response site
NA	not applicable
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	no further action
O&M	operations and maintenance
Pd	probability of detection
PRG	preliminary remediation goal
RAO	remedial action objective
RC1	Range Complex 1
RC2	Range Complex 2
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROE	Rights of Entry
RSL	regional screening level
RGK	real time kinematic
RTS	Robotic Total Station
SAM	sub audio magnetics
SERDP	Strategic Environmental Research and Development Program
SUXOS	Senior UXO Supervisor
TBC	to be considered
TDEMI	Time-Domain Electromagnetic Induction
TMV	toxicity, mobility, and volume
TNT	trinitrotoluene
TOI	target of interest
TP	Technical Paper
TPV	total present value
USACE	U.S. Army Corps of Engineers
USAESCH	U.S. Army Engineering and Support Center, Huntsville
USEPA	U.S. Environmental Protection Agency
USRADS	Ultrasonic Ranging and Detection System
UU/UE	unlimited use/unrestricted exposure
UXO	unexploded ordnance
UXOSO	UXO Safety Officer
UXOQCS	UXO Quality Control Specialist

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1.0 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This Feasibility Study (FS) addresses the Camp Butner Training Areas Munitions Response Area (MRA). The MRA consists of the former MRAs [Range Complex 1 (RC1), Range Complex 2 (RC2), Flame Thrower Range (FTR), and North Carolina Army National Guard (ARNG)] within the former Camp Butner ("Butner")
located in Granville, Person, and Durham counties, North Carolina. This FS has been prepared for the U.S. Army Engineering and Support Center, Huntsville (USAESCH) under Contract No. W912DY-10-D-0023, Delivery Order 0009.

1.1.2 The objectives of this FS are to evaluate potential remedial action alternatives and recommend the most appropriate remedial approach for each proposed MRS. To meet these objectives, the scope of this FS includes the following:

- Summarizing site characteristics;
- Developing a remedial action objective (RAO);
- Identifying general response actions (GRAs) and remedial alternative that address the RAO;
- Conducting a detailed analysis of the identified remedial alternatives according to the standard U.S. Environmental Protection Agency (USEPA) evaluation criteria; and

1.1.3 Following completion of the FS, the preferred alternatives for the MRSs will be recommended in a Proposed Plan. After responding to public comments on the Proposed Plan, the identified remedy will formally be selected and documented in a Decision Document according to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

1.2 BACKGROUND

1.2.1 Camp Butner was primarily established to train infantry, artillery, and engineering combat troops for deployment and redeployment overseas during World War II. The installation was active from 1942 until 1946; however, training was only conducted through 1943. Construction of Camp Butner was authorized by the War Department on February 12, 1942. The camp was officially

activated on August 4, 1942 and occupied approximately 40,384 acres. The various acres compiling Former Camp Butner were acquired by the War Department by:

- 40,201 acres acquired in fee;
- 128.4 acres acquired in 82 easements;
- 2.5 acres acquired in licenses; and
- 52.4 acres acquired in 26 leased tracts (USACE, 1993).

1.2.2. The acquired acreage was owned by multiple private owners and consisted of rural agricultural, undeveloped wooded, commercial, and residential land use parcels. Camp Butner was established to train infantry divisions and miscellaneous artillery and engineer units. Camp Butner was declared excess by the War Department on January 31, 1947. The installation included approximately 15 live-fire ammunition training ranges, a grenade range, a 1,000-inch range, a gas chamber, and a flame thrower training pad. Munitions used at the site included small arms, 2.36-inch rockets, rifle and hand grenades, 20-millimeter (mm) through 240 mm high explosive (HE) projectiles, 60 and 81 mm mortars, and antipersonnel practice mines. Training activities also included the use of demolition items such as trinitrotoluene (TNT) and various initiating and priming materials. Following World War II, the camp was closed, limited ordnance clearances were performed, and the property was conveyed to the ARNG, the State of North Carolina, local municipalities, and private owners.

1.2.3 Camp Butner is located 15 miles north of Durham, North Carolina, and encompasses approximately 40,384 acres in Granville, Person, and Durham counties. Most of the land is used for agricultural purposes, but also includes residences. The agricultural uses include timber forests, various crops and livestock grazing, with rural residential development throughout. Regionally, the land use is a combination of localized cropland clearings located within expanses of woodland and rural residential development.

1.3 REMEDIAL INVESTIGATION SUMMARY

1.3.1 The focus of the remedial investigation (RI) was on the five former MRAs, including: RC1, RC2, ARNG, Hand Grenade Range (HGR), and FTR. The RI indicated that there is evidence of historical munitions use or remaining munitions and explosives of concern (MEC) at the RC1, RC2, FTR, and ARNG MRAs, and in consideration of the accessibility and land use, the risk of encounter and incident to occur is unacceptable. Additionally, the RI concluded that no threat to human health or the environment is present from munitions constituents (MC) in soil. The RI results were used to define MEC-Contaminated AOIs for revision to the current MRA boundary and to support the development and execution of potential remedial alternatives as part of the recommended FS. The MEC contaminated area of each proposed MRS, as well as the Buffer AOI MRSs identified in the RI were recommended to go forward to this FS evaluation. The Buffer AOI MRSs are the portions of each proposed MRS where munitions debris (MD) only was identified. Detailed descriptions of the proposed MRSs investigated during the RI is included in Section 2.2.8 and the recommendations for evaluation in this FS are included in Section 2.3.

1.3.2 The ARNG property is eligible for FUDS and is not considered a PRP because the ARNG installation has only been used for small arms (since transfer of the property by DoD) and was documented by a memorandum for record (14 June 2012) located on FRMD

(I04NC000902_03.01_0507) and Savannah District Real Estate documentation (I04NC000902_01.01_0002).

1.4 FEASIBILITY STUDY SUMMARY

1.4.1 Based on the findings and recommendations of the RI, an FS was conducted to identify and evaluate remedial action alternatives for the MEC-Contaminated AOI to address explosive hazards. During preparation of this FS, the MEC-Contaminated AOIformer MRAs were further evaluated and sub-divided into proposed MRSs. The MEC contaminated area is recommended to be divided into the proposed MRSswithin the FS listed in Table 1.1. The RAOs developed for the MRSs are summarized in Table 1.2. The remedial action alternatives listed below were developed for initial consideration within the proposed MRSs:

- Alternative 1: No Action
- Alternative 2: LUCs (Public Education and Signs)
- Alternative 3: Surface Clearance with Analog Detection Methods, and LUCs
- Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Digital Geophysical Mapping (DGM) Methods (UU/UE Method A)
- Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Table 1-1
Proposed MRSs Evaluated in this FS

Proposed MRS*	Land Use	Acreage*
MRS-01	Military Training MEC Contaminated AOI	1,429
MRS-02	Military Training Buffer AOI	391
MRS-03	Buffer AOI	924
MRS-04	Central MEC Contaminated AOI	2,202
MRS-05	Northern MEC Contaminated AOI	1,807
MRS-06	Eastern MEC Contaminated AOI	1,451
MRS-07	Western MEC Contaminated AOI	1,385
MRS-08	South MEC Contaminated AOI	1,179
MRS-09	No Further Action	7,149

**Proposed sub-division of the former RC1, RC2, FTR, and ARNG MRAs*

1.4.2 A detailed analysis was completed for each retained alternative using seven of the nine evaluation criteria, as defined by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Section 5.0). The purpose of the detailed analysis was to evaluate and compare the identified remedial action alternatives to then develop a Proposed Plan for regulatory agency and public review.

Table 1-2 Remedial Action Objectives

Proposed MRS	Remedial Action Objective
MRS-01	Mitigate the unacceptable risk of an incident to occur for ARNG users over 1,429 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
MRS-02	Mitigate the unacceptable risk of an incident to occur for ARNG users over 391 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
MRS-03	Mitigate the unacceptable risk of an incident to occur for human receptors over 924 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
MRS-04	Mitigate the unacceptable risk of an incident to occur for human receptors over 2,202 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
MRS-05	Mitigate the unacceptable risk of an incident to occur for human receptors over 1,807 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
MRS-06	Mitigate the unacceptable risk of an incident to occur for human receptors over 1,451 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
MRS-07	Mitigate the unacceptable risk of an incident to occur for human receptors over 1,385 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
MRS-08	Mitigate the unacceptable risk of an incident to occur for human receptors over 1,179 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.

2.0 INTRODUCTION

2.0.1 This FS was conducted for Formerly Used Defense Site (FUDS) property No. I04NC00902, Camp Butner, which is located 15 miles north of Durham, North Carolina, and encompasses approximately 40,384 acres in Granville, Person, and Durham counties. A site location map is provided as Figure 2.1. The Camp Butner Training Areas Munitions Response Area (MRA) is a realignment of the former MRAs [Range Complex 1 (RC1), Range Complex 2 (RC2), Flame Thrower Range (FTR)] and includes the North Carolina Army National Guard (ARNG). The MRA totals 16,442 acres.

2.0.2 Information to prepare this FS was derived from the Final RI Report at former Camp Butner (HGL, 2016). To stay consistent with previous investigations, the RI subdivided the MRA back to the former MRAs and ARNG for organizational purposes and recommended that 9,456 acres where MEC was confirmed and 1,390 acres where MD was confirmed go forward to the FS phase. The acreage of these areas and the names of the areas used in the Final RI Report are:

- MEC-Contaminated AOI 9,430 acres
- Buffer AOI 1,390 acres
- FORMER FTR MRA 20 acres
- ARNG HGR AOI MRS 6 acres

2.0.3 The RI concluded that there were no unacceptable risks to human health or ecological receptors at the project sites from MC. Therefore, MC contamination is not addressed in this FS. A detailed discussion of the RI results and conclusions is provided in Section 2.2. Additionally, a discussion of the RI Report conclusions is provided in Section 2.2 and a description of the acreage of each of the proposed MRSsincluded in this FS is provided in Section 2.3.

2.0.4 This FS documents the development and detailed evaluation of remedial alternatives proposed to address unacceptable explosive risks from MEC. This FS supports ongoing CERCLA activities at former Camp Butner and has been prepared in accordance with 40 Code of Federal Regulations (CFR) 300.430(e) *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA,* (USEPA, 1988); USACE's Engineer Pamphlet 1110-1-18: Ordnance and Explosives Response (USACE, 2006); and *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (USEPA, 2000).

2.0.5 The primary objective of this FS is to develop and evaluate appropriate remedial actions and present relevant information about the remedies applicable to Camp Butner. Risk management and remedial actions are developed into potential remedial action alternatives that are compared and evaluated in this FS. The FS is organized as follows:

- **Section 1.0 – Executive Summary –** Provides a summary of the purpose, scope, and objectives of the FS; site background information; previous investigation data and interpretation; summary of alternatives; and conclusions.
- **Section 2.0 – Introduction:** Presents the report organization, purpose, the RI findings, and basis of the FS.

- **Section 3.0 – Identification and Screening of Remedial Technologies for MEC and MC:** identifies contaminants of concern, RAOs, and preliminary remediation goals (PRGs). In addition, Section 3.0 includes the initial screening of remedial technologies.
- **Section 4.0 – Development and Screening of Alternatives:** presents and screens the remedial action alternatives.
- **Section 5.0 – Detailed Analysis of Alternatives**: evaluates the remedial action alternatives individually and provides a comparison between remedial action alternatives for future decision making.
- **Section 6.0 – References:** lists the references used to prepare this report.
- **Appendix A - Cost Calculations**

2.1 PURPOSE

2.1.1 The purpose of this FS is to provide an evaluation of potential remedies to address MEC contamination identified within former Camp Butner. In accordance with 40 CFR 300.430(e), this FS develops remedial action alternatives and provides an evaluation to assist decision makers in selection of the most appropriate remedy. The FS process is designed to:

- Develop potential alternatives that adequately manage hazards and risks;
- Analyze the alternatives against the nine criteria identified in the NCP (40 CFR 300); and
- Compare the developed alternatives against one another.

2.1.2 CERCLA contains several statutory provisions with which all remedies must comply. These include protection of human health and the environment, compliance with applicable or relevant and appropriate requirements (ARARs), cost effectiveness and a preference for permanence and for treatment that reduces TMV. To satisfy these CERCLA requirements, the NCP (40 CFR 300.430[e][9]) identifies nine criteria against which potential remedies are judged, as summarized in Table 2-1.

Table 2-1
Nine NCP Criteria for Detailed Analysis of Remedial Alternatives

Threshold Criteria	1. Overall protection of human health and the environment 2. Compliance with ARARs
Primary Balancing Criteria	3. Long-term effectiveness and permanence 4. Reduction of TMV through treatment 5. Short-term effectiveness 6. Implementability 7. Cost
Modifying Criteria	8. State acceptance (not evaluated at this time) 9. Community acceptance (not evaluated at this time)

2.2 SUMMARY OF REMEDIAL INVESTIGATION FINDINGS

2.2.1 Introduction

2.2.1.1 As stated in Section 2.0.2 above, an RI report was completed investigating potential MEC and MC contamination within Camp Butner. Specifically, the RI report focused on five fomer MRAs: RC1, RC2, ARNG, HGR, and FTR. Historical activities and previous investigations indicated the potential for contamination within these MRAs.

2.2.1.2 To support MEC characterization at the project site, DGM surveys, mag-and-dig, and intrusive investigation were planned throughout the project site, except for the former HGR MRA (25 acres) and the former FTR MRA (5 acres). No evidence was found during previous investigations of the former HGR MRA; therefore, no additional field data collection was performed under the RI. Additionally, the former HGR MRA was not recommended in the RI for inclusion within the FS. MEC has been confirmed within the former FTR MRA; although it was found in smaller amounts than the other former MRAs. It was determined that the nature and extent of the former FTR MRA had been adequately characterized in previous investigations; therefore, no additional data collection was performed during the RI.

2.2.1.3 In general, areas where MEC or significant amounts of munitions debris (MD) were found were characterized as MEC contaminated within each former MRA. This analysis resulted in the identification of the MEC contaminated areas and MD containing areas in RC1, RC2 and ARNG MRAs, which were recommended for continuation forward to the FS phase. Additionally, a new ARNG HGR Area of Interest (AOI) was identified and delineated during the RI investigation. Due to historical usage of ARNG for only small arms, the AOI was recommended in the RI report to be created as a new MRS within former Camp Butner and inclusion within the FS.

2.2.1.4 Overall, depth ranges for MEC contamination were estimated using the mean and maximum depths at which MEC and/or MD items were recovered in the MEC-Contaminated AOIs. Of the MEC items identified during the RI, all were found from the surface to 0.5 ft below ground surface (bgs). Only 2 items of MD were found at depths of 3 ft bgs to 3.33 ft. Of the MD located during the intrusive effort a total of 98 percent was found from the surface to 2-ft bgs. A more detailed depth breakdown includes: 83 percent of MD found from the surface to 1 ft bgs, 15 percent was found from 1 ft bgs to 2 ft bgs, and 2 percent was found at depths of 2 ft to 3.33 ft bgs. A more detailed summary of the RI activities and results for each proposed MRS is provided below. Evaluation of all historical MEC and MD findings from all investigations, including the RI, is discussed in Section 3.1.2.

2.2.1.5 During the RI fieldwork, incremental sampling methodology (ISM) soil samples were also collected from within ARNG, RC1, RC2, and at background locations. Samples were analyzed for explosives and metals (antimony, copper, lead, and zinc). No MC was detected at levels constituting a risk to human health or the environment. Therefore, MC contamination is not addressed in this FS.

2.2.2 Former Range Complex 1 MRA

2.2.2.1 The former RC1 MRA is the most of the center of the Camp Butner MRA which contained an artillery impact area, two mortar ranges, and several small arms ranges for a total of 12,363 acres. All range fans remain within site boundaries, and some range fans overlap with others within the complex. Munitions types identified at RC1 included small arms, 2.36-inch rockets; hand grenades; rifle grenades; 37mm, 40mm, 57mm, 105mm, and 155mm projectiles; and 60mm and 81mm mortars.

2.2.2.2 At the former RC1 MRA, full coverage grid surveys were completed over 3.4 acres of the site, with an additional 1.4 acres of grid coverage completed by analog methods. Five 25-ft x 25-ft grids were distributed throughout the high anomaly density areas. Thirty-four 50-ft x 50-ft grids were placed across the medium density areas. Thirty-eight grids were placed within the low-density areas. The right-of-entry (ROE) granted at this MRA are shown in Figure 2.2b. A total of 749 targets were selected for intrusive investigation which resulted in: only 1 MEC item, a 2.36-inch rocket warhead; 243 MD items; and 283 miscellaneous farm debris. The remaining 161 targets consisted of "same as" another nearby target, geologic false positives, and no finds. One MEC item (57 mm HE projectile, unfuzed) was identified during geophysical data collection. Two additional 57 mm projectiles were identified in the same location while establishing the location for demolition operations. The deepest anomaly investigation during the RC1 intrusive was 28-inches bgs and located a piece of MD. The majority of MD found (82 percent) was located less than 2-ft bgs, see paragraph 2.2.1.4 and Tables 2-5 through 2-12.

2.2.3 Former Range Complex 2 MRA

2.2.3.1 The former RC2 MRA is located on the north side of the Camp Butner MRA which contained an artillery impact area, a mock village and two machine gun ranges for a total 11,529 acres. Munitions types identified at RC2 included small arms, 2.36-inch rockets; hand grenades; rifle grenades; 37mm, 40mm, 57mm, 105mm, and 155mm projectiles; and 60mm and 81mm mortars.

2.2.3.2 The full coverage grid surveys were completed over 5.3 acres of the former RC2 MRA, with an additional 0.7 acres of grid coverage completed using analog methods. Seventeen 25-ft x 25-ft grids were distributed throughout the high anomaly density areas. Thirty-seven 50-ft x 50-ft grids were placed across the medium density areas. Thirty-two grids were placed within the low-density areas. Nineteen of either 10-ft x 150-ft grids or 10-ft x 250-ft grids were located on the medium-high and low-medium density boundaries, oriented perpendicular to the anomaly density gradient. A total of 69 miles of EM-61 digital transects, 48.7 miles of reconnaissance transects, 0.7 miles of analog transects, 101 grids DGM surveyed (90 of the DGM grids were intrusively investigated) and 13 analog intrusive grid investigations were completed within the former RC2 MRA. The ROE granted at this site are shown in Figure 2.2b. A total of 1,303 targets were selected for intrusive investigation; 2 targets resulted in a MEC item found (37 mm practice projectile with M58 practice fuze), 818 were MD items, and 247 were cultural debris. The remaining 236 targets consisted of "same as" targets, seeds, geology, false positives, and no finds.

2.2.4 Army National Guard Former MRA

2.2.4.1 The ARNG former MRA contains a total of 4,824 acres. It is located on the western-central area of Butner MRA and contained an artillery impact area, two mortar ranges, and several small arms ranges. The range fan for the artillery impact area was confirmed using historical maps; however, the dimensions of the other range fans were established using standard range fans for the individual type of range. All range fans remain within site boundaries, and some range fans overlap with others within the complex. Munitions found, or suspected, include small arms, 2.36-inch rockets; rifle grenades 60mm and 81mm mortars; and 37mm, 105mm, and 155mm projectiles.

2.2.4.2 Full coverage grid surveys were completed within the ARNG former MRA in areas of high, medium, and low anomaly densities over 4.6 acres of the site. Eleven 25-ft x 25-ft grids were distributed throughout the high anomaly density areas. Twenty-eight 50-ft x 50-ft grids were placed within the medium density areas and 22 grids were placed in the low-density areas. Seventeen of either 10-ft x 150-ft grids or 10-ft x 250-ft grids were located on the medium-high and low-medium density boundaries, respectively, oriented perpendicular to the anomaly density gradient. These 78 grid locations were modified slightly based on vegetation or terrain within limits set forth in the grid location memo. Based on the results of the reconnaissance survey transects completed outside the interpreted impact area and historical MEC use areas, an additional 11 grids were placed outside the interpreted impact area. A total of 49.3 miles of EM-61 digital transects, 29 miles of reconnaissance transects, and 89 intrusive investigation grids were completed within the ARNG former MRA. There were no ROE refusals (Figure 2.2b). A total of 1,382 targets were selected for intrusive investigation; 6 targets resulted in MEC items, 657 were MD items, and 475 were miscellaneous farm debris. The remaining 144 targets were described by the field teams as “same as” another nearby target, or were noted as geologic false positives, or no finds.

2.2.5 Army National Guard Hand Grenade Range AOI

2.2.5.1 During investigations conducted outside the interpreted impact area of the ARNG former MRA, intrusive investigations resulted in the discovery of a previously unknown hand grenade range (6 acres). The grid location was selected based on results of the reconnaissance transects and the historical analysis. During intrusive investigations, 39 anomalies were intrusively investigated and a total of five MkII hand grenades (all identified as MEC) were discovered. These were destroyed in accordance with the approved work plan on the same date. HydroGeoLogic, Inc. (HGL) conducted eight additional analog transects and identified trenches associated with the ARNG HGR AOI. Based on the location of the trenches and the MEC found, the range was oriented so that the soldiers threw the grenades to the north. ARNG HGR AOI was delineated and was recommended in the RI as a new MRS within former Camp Butner. No MC samples were collected from the ARNG HGR AOI.

2.2.6 MEC HA Results Summary

2.2.6.1 MEC was confirmed in the surface and subsurface at the former ARNG, RC1, RC2, FTR MRAs, as well as the ARNG HGR AOI. The potential explosive safety risks using the MEC Hazard Assessment (HA) method, as established in the Final RI Report, for each site are summarized in Table 2-2. The former FTR MRA resulted in hazard level 4 (low), primarily due to

the "amount of MEC" and "Minimum MEC Depth Relative to Maximum Receptor Intrusive Depth" input factors. The 5-acre site has undergone a clearance action from 2 to 3 ft deep and intrusive activities performed by current receptors and current land use are unlikely to expose additional MEC. As result, the hazard level indicates low potential explosive hazard conditions. Since no MEC, or evidence, was present at the former HGR MRA, no MEC HA was required. This information provides the baseline for the assessment of remedial alternatives within this FS.

Table 2-2
Summary of MEC HA Baseline Scores for Camp Butner MRSs

	MRS					
MEC HA Input Factor	**ARNG**	**ARNG Hand Grenade Range**	**RC1**	**RC2**	**FTR**	**HGR**
Energetic Material Type	100	100	100	100	70	NA
Location of Additional Human Receptors	0	0	30	30	30	NA
Site Accessibility	80	80	80	80	80	NA
Potential Contact Hours	70	70	120	120	20	NA
Amount of MEC	180	180	180	180	30	NA
Minimum MEC Depth Relative to Maximum Receptor Intrusive Depth	240	240	240	240	25	NA
Migration Potential	10	10	10	10	10	NA
MEC Classification	180	180	180	180	180	NA
MEC Size	40	40	40	40	40	NA
TOTAL SCORE	900	900	980	980	485	NA
HAZARD LEVEL	**1**	**1**	**1**	**1**	**4**	**NA**

NA: Not applicable

2.2.7 Conclusions of the RI

2.2.7.1 The conclusions of the RI and the MEC HA show that explosive hazards from MEC potentially exists to current and future receptors. The RI results were sufficient to characterize, identify and evaluate MEC hazards associated with the entire project site, and were used to define MEC-contaminated areas laterally for revision to the proposed MRS boundaries. The vertical extent of contamination established in the RI ranged from the surface to 2.0 ft bgs based on no MEC identified below 2.0 ft bgs and only 2 percent of the MD identified found deeper than 2.0 ft bgs. Additionally, results from prior investigations conducted were incorporated in the MEC contamination boundary delineation. These areas were recommended for inclusion in an FS, and the proposed MRS boundaries and the RI results are shown in the Figures 2.2 and 2.3.

2.2.8 RI Recommendations and Feasibility Study MRSs

2.2.8.1 Based on the RI and historical investigation results, a distinction was made between the areas with a higher potential for MEC hazards and with a lower potential for MEC hazards and recatagorized into new AOIs. Areas where MEC was identified were included in the MEC-Contaminated AOI, even when a removal action had already been conducted on the parcel. The presence of MEC and MD (as counts per grid) was compared to all other data (historical data,

anomaly density based on DGM transects, and reconnaissance transects) to determine whether the area should be defined as MEC contaminated. Based on these findings, grids with minor amounts (less than 5 pieces) of MD were not recommended for the MEC contaminated area. For grids with MD identified with more than 5 pieces per grid, the area was defined as MEC contaminated. If a grid contained only 1 or 2 pieces of MD, the area was considered to have minor amounts of MD and was not included within the MEC contaminated area, based on all other data described above.

2.2.8.2 The RI recommended that acreage determined to have a lower potential MEC hazard based on minor amounts of MD (1 or 2 pieces of MD per grid) become a separate AOI in the future. The low density area was recommended to be evaluated in the FS as the Buffer AOI. Parcels outside the MEC-Contaminated AOI and/or the Buffer AOI were recommended for No Further Action in the RI. The MEC-Contaminated AOI boundary and the Buffer AOI boundary extends through the ROE refusal parcels, with the location of the boundary extrapolated based on nearby data. Table 2-3 summarizes the acreage of each FS area recommended in the conclusions of the RI. These areas are shown in Figure 2.2.

Table 2-3
MRSs Recommended for FS Within the RI

RI Recommended Areas	Revised Acreage	Potential MEC Hazards	MC Risk Present	Recommendation
MEC-Contaminated AOI*	9,430	High	No	FS
Buffer AOI	1,390	Low	No	FS
FORMER FTR MRA	20	Low	No	FS
ARNG HGR AOI	6	High	No	FS

**This is the total of all acres determined to be MEC-contaminated from the previously investigated MRAs named separately as the ARNG, RC1, and RC2 MRAs.*

2.3 PROPOSED MUNITIONS RESPONSE SITES

2.3.1 During preparation of this FS, the MEC-Contaminated AOI was further evaluated for current land use and munitions confirmed to be present. Areas associated with each land use category and munitions type were identified. The MEC contaminated area determined during the RI is recommended to be divided into nine proposed MRSs, based on the identified and predominant land uses and munitions. Proposed MRS-01 includes MEC contaminated areas which are used for military training; proposed MRS-02 includes Buffer AOIs which are used for military training; proposed MRS-03 includes all Buffer AOI area not used for military training; proposed MRS-04, proposed MRS-05, proposed MRS-06, proposed MRS-07and proposed MRS-08 are separate MEC contaminated areas divided by geographic location and munitions types. Proposed MRS-09 are all the no further action (NFA) acres which were part of the FUDS property defined in the Formerly Used Defense Sites Management Information System (FUDSMIS), but not part of a recommended MEC Contaminated area, based on the updates made to the FUDS property boundaries in FUDSMIS in 2014. Proposed MRS-09 also includes the Hand Grenade Range and the Gas Chamber (tear gas training) which are also recommended for No Further Action based on historical information. The No Further Action acres are not recommended for response action. The acreages of the proposed MRSs are shown in Table 2-4 below. These proposed MRSs will be evaluated in this FS and are shown along with RI results on Figure 2.3. Additionally, Figure 2.4 shows the proposed MRSs without the RI results displayed.

2.3.2 During preparation of this FS, comparison of the FUDS property boundary, the FUDSMISMRA boundary, and the individual former MRA boundaries used in the RI report were compared to the current data recorded in FUDSMIS, the USACE repository which documents FUDS property acreages. Discrepancies in the total acreages and the property boundaries were identified, the shapefiles when compared to the GIS calculated acreages do not match historical figures for the MRSs. The boundaries used did not match the historical record; therefore, based on the evaluation of USACE real estate information for Camp Butner, the most accurate, updated acreages were re-calculated. The proposed MRS boundaries are shown on Figure 2.4 and the acreages are listed in Table 2-4. These calculations reflect the most current GIS data available for these MRSs. Improvements in GIS data over time support an updated calculation of the FUDS property acreages. Therefore, acreages summarized in the RI Report for the FUDS property boundary, acreages summarized in this FS, and the future proposed MRSswill not match current FUDSMIS totals.

Table 2-4
Proposed MRSs for the Feasibility Study

Proposed MRS	RI AOIs*	Land Use*	Acreage	Acres within MRS	Increased Acreage
MRS-01	Military Training MEC Contaminated AOI	ARNG	1,429.4	1,425.7	3.7
MRS-02	Military Training Buffer AOI	ARNG	390.9	390.9	0
MRS-03	Buffer AOI	Mixed residential, commercial, recreational, and agricultural	923.5	848.8	74.8
MRS-04	MEC Contaminated AOI (Central)	Mixed residential, commercial, recreational, and agricultural	2,201.8	1,671.4	530.4
MRS-05	MEC Contaminated AOI (Northern)	Mixed residential, commercial, recreational, and agricultural	1,806.5	1,677.8	128.7
MRS-06	MEC Contaminated AOI (Eastern)	Mixed residential, commercial, recreational, and agricultural	1,450.8	1,023.8	427.1
MRS-07	MEC Contaminated AOI (Western)	Mixed residential, commercial, recreational, and agricultural	1,384.7	1,348.4	36.3

Proposed MRS	RI AOIs*	Land Use*	Acreage	Acres within MRS	Increased Acreage
MRS-08	MEC Contaminated AOI (South)	Mixed residential, commercial, recreational, and agricultural	1,178.8	1,161.6	17.2
MRS-09	FTR MRA, ARNG HR AOI, and No Further Action areas within FUDSMIS	Mixed residential, commercial, recreational, and agricultural	7,148.2	7,148.2	0
	TOTAL ACRES		17,914.6	16,696.6	1,218.2

Note: Total acres of the MRSs calculated by GIS is 16,696 acres, see paragraph 2.3.2.
**Current and projected land use are anticipated to remain the same.*

2.4 NON-ROE PROPERTIES

2.4.1 All proposed MRSs have portions where the property owner has refused access. Extrapolated data from surrounding properties has been used to determine potential hazard risk and in eachwhich proposed MRS that the properties would be included. If properties are inaccessible during the remedial action, then these properties will be delineated from the proposed MRS and into a Non-ROE MRS. Remedial action within the Non-ROE MRS will be pending until access is granted.

2.5 HISTORICAL DEPTH OF MUNITIONS PRESENT IN EACH PROPOSED MRS

2.5.1 Based on the proposed MRS boundaries being used in this Feasibility Study, a re-evaluation of the locations of MEC and MD found, along with the depth information (if available), is shown on the following tables for each proposed MRS listed in Table 2-4. This information was compiled from historical investigations and removal actions completed previously and munitions nomenclature and depth information was sometimes missing or incomplete. Historical data was compiled with the current RI data and the summary tables from each proposed MRS are listed below. Based on the two distinct target areas determined to be present at these proposed MRSs, the lack of presence of a munition within the proposed MRS does not necessarily indicate that it will not potentially occur in each proposed MRS.

Table 2-5
Historical Depth of MEC and MD Identified in PROPOSED MRS-01

Munition	Classification	PROPOSED MRS-01 Depth Range (inches)
3.25-inch Target Rocket	MD	30
30 mm HE projectile (expended)	MD	3
37 mm projectile	MEC/MD	2-6
57 mm projectile	MEC	Surface
57 mm projectile (AP-T, HE)	MD	6-14

Munition	Classification	PROPOSED MRS-01 Depth Range (inches)
60 mm HE mortars	MEC	0-12
60 mm mortar (fins, frag, tail boom, expended fuze)	MD	0-12
75 mm projectile (base)	MD	6
81 mm mortar (fin, frag, tail boom)	MD	3-4
Hand grenade	MEC	5-18
Rifle grenade (illumination-spent, frag)	MD	2-6
Slap flare	MD	1
T-bar fuze	MD	0-23
Unknown Frag	MD	0-40
Unknown Mortar Frag (fins and booms)	MD	4-10

Table 2-6
Historical Depth of MEC and MD Identified in Proposed MRS-02

Munition	Classification	Proposed MRS-02 Depth Range (inches)
60 mm mortar (fins, frag, tail boom, expended fuze)	MD	0-12
Unknown Frag	MD	0-40

Table 2-7
Historical Depth of MEC and MD Identified in Proposed MRS-03

Munition	Classification	Proposed MRS-03 Depth Range (inches)
37 mm projectile	MD	2-6
57 mm projectile (AP-T, HE)	MD	6-14
Unknown Frag	MD	0-40

Table 2-8
Historical Depth of MEC and MD Identified in Proposed MRS-04

Munition	Classification	Proposed MRS-04 Depth Range (inches)
105 mm (MK1, HE)	MEC	Surface
155 mm (projectile, rotating band)	MEC/MD	3
2.36-inch rocket	MEC	3-6
37 mm projectile	MEC/MD	2-6
60 mm Mortar	MEC	6-8
81 mm Mortar	MEC/MD	0-32
T-bar fuze	MD	0-23
Unknown Frag	MD	0-40

Table 2-9
Historical Depth of MEC and MD Identified in Proposed MRS-05

Munition	Classification	Proposed MRS-05 Depth Range (inches)
105 mm (MK1, HE)	MEC	Surface
2.36-inch rocket	MEC	3
37 mm projectile	MEC/MD	2-6
40 mm projectile (expended)	MD	6
57 mm projectile (AP-T, HE)	MD	6-14
MKII HE Hand Grenade	MEC	4
T-bar fuze	MD	0-23
Unknown Frag	MD	0-40

Table 2-10
Historical Depth of MEC and MD Identified in Proposed MRS-06

Munition	Classification	Proposed MRS-06 Depth Range (inches)
2.36-inch rocket	MEC	3-6
37 mm projectile	MEC/MD	2-6
81 mm Mortar	MEC/MD	0-32
Unknown Frag	MD	0-40

Table 2-11
Historical Depth of MEC and MD Identified in Proposed MRS-07

Munition	Classification	Proposed MRS-07 Depth Range (inches)
2.36-inch rocket warhead	MEC	2
37 mm projectile	MEC/MD	2-6
57 mm projectile (AP-T, HE)	MD	6-14
Unknown Frag	MD	0-40

Table 2-12
Historical Depth of MEC and MD Identified in Proposed MRS-08

Munition	Classification	Proposed MRS-08 Depth Range (inches)
105 mm (MK1, HE)	MEC	Surface
60 mm Mortar	MEC	6-8
81 mm Mortar	MEC/MD	0-32
Grenade pins and spoons	MD	1-3
M1 Mine Spotting Charge	MEC	2-3
M1A1 Mine and Practice Landmine	MEC/UXO/MD	0-12

Munition	Classification	Proposed MRS-08 Depth Range (inches)
M1A1 Smoke Cartridge	MD	0-6
M9 Rifle Grenade	MEC	3
Smoke Grenade (expended)	MEC	Surface
Smoke Grenade frag	MD	0-8
Smoke Pot	MEC	3
Unknown Frag	MD	0-40
WP Grenade	MEC/MD	0-8

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3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES FOR MEC AND MC

3.0.1 The process used for developing and screening technologies includes establishing RAO and developing general response objectives. The following sections provide details regarding the ARARs, RAO, general response objectives, and remedial technologies.

3.1 REMEDIAL ACTION OBJECTIVES

3.1.1 Applicable or Relevant and Appropriate Requirements and TBCs

3.1.1.1 Response actions under CERCLA must identify and attain or formally waive what are determined to be ARARs under federal and state laws (NCP, 40 CFR 300.400[g]). Although the RI is not considered a response action, preliminary identification of chemical-specific and location-specific ARARs begins during the RI process. ARARs are used as a starting point for determining the protectiveness of a potential remedy. The ability to comply with ARARs also affects the acceptability of the potential remedy to state regulators and community stakeholders. When ARARs do not exist for a particular chemical or remedial activity, other criteria, advisories, and guidance referred to as to-be-considered (TBC) requirements are useful in designing and selecting a remedial alternative.

3.1.1.2 ARARs are grouped into the following three categories:

- **Chemical-Specific ARARs:** These are usually health- or risk-based numerical values or methodologies. Applying these numerical values establishes the acceptable amount or concentration of a chemical that may exist in a medium or that may be discharged to the environment.
- **Action-Specific ARARs:** These are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous waste.
- **Location-Specific ARARs:** These include restrictions placed on the concentrations of hazardous substances or the conduct of activities solely because they occur in special locations.

3.1.1.3 Chemical-specific ARARs are considered when developing RAO and establishing preliminary remediation goals. Action- and location-specific ARARs are considered when identifying potential GRAs. No location-specific, or chemical-specific ARARs have been identified for Camp Butner. One action-specific ARAR has been identified, the Resource Conservation and Recovery Act (RCRA) Subpart X 40 CFR 264.601. Any consolidated shot, or consolidated and blow activities, would need to adhere to RCRA rules. Waste material (such as deposition of explosives and metals in soil) resulting from disposal activities will be characterized by soil sampling in accordance with requirements.

3.1.1.4 TBC criteria are nonpromulgated, nonenforceable guidelines or criteria that may be useful for developing an interim action or are necessary for determining what is protective to human health and/or the environment. These TBC requirements complement the use of ARARs but do

not compete with or replace them (USEPA, 1992). There are no TBC criteria for MEC relative to human health and ecological receptors identified.

3.1.2 Identification of Remedial Action Objectives

3.1.2.1 RAOs address the goals for reducing the MEC hazards to ensure protection of human health, safety and the environment (USEPA, 1992). There is no MC risk to human health and the environment at Camp Butner. Therefore, development of the RAOs involves the identification of MEC contamination at each proposed MRS, along with an evaluation of the exposure pathways and potential receptors. The potential receptors vary within the proposed MRSs at Camp Butner, based on specific land use. Across Camp Butner, the following land use categories occur: residential, commercial/industrial, agriculture, undeveloped woodlands, recreational, and military training. Other than the two exclusively military training areas (Proposed MRS-01 and Proposed MRS-02) all other land uses are present on all proposed MRSs. Potential land use common across all proposed MRSs is construction which could include utility installation to depths of up to 15 ft.

3.1.2.2 The PRGs for these proposed MRSs are to reduce MEC exposure by a combination of removal, administrative controls and/or public education. Based on the MEC identified within these proposed MRSs and the depth that historical munitions were identified, along with the proposed MRS-specific DGM Depth of Detection, a summary of anticipated depths was developed for the munitions anticipated in each proposed MRS (Table 3-2 and Table 3-3). Since potential land use is deeper than historical munitions depth, munitions depths will be used to set the vertical limits of the RAO for each proposed MRS. The RAO proposed for the response actions is provided in Table 3-1 and incorporates by reference the DGM library depth of detection information summarized in Table 3-3 and the historical depths that munitions were detected in Table 3-2. The depths MEC is detected and removed will be evaluated post-removal action to verify that RAOs were protective and whether UU/UE is achieved.

Table 3-1
Remedial Action Objectives

MRS	Remedial Action Objective
Proposed MRS-01	Mitigate the unacceptable risk of an incident to occur for ARNG users and tresspassers over 1,429 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
Proposed MRS-02	Mitigate the unacceptable risk of an incident to occur for ARNG users and tresspassers over 391 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
Proposed MRS-03	Mitigate the unacceptable risk of an incident to occur for workers, recreational users, and residents over 924 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.

MRS	Remedial Action Objective
Proposed MRS-04	Mitigate the unacceptable risk of an incident to occur for workers, recreational users, and residents over 2,202 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
Proposed MRS-05	Mitigate the unacceptable risk of an incident to occur for workers, recreational users, and residents over 1,807 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
Proposed MRS-06	Mitigate the unacceptable risk of an incident to occur for workers, recreational users, and residents over 1,451 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
Proposed MRS-07	Mitigate the unacceptable risk of an incident to occur for workers, recreational users, and residents over 1,385 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.
Proposed MRS-08	Mitigate the unacceptable risk of an incident to occur for workers, recreational users, and residents over 1,179 acres to the detection depths of the applicable munitions of concern listed in Table 3-2 such that a determination can be made that there is a negligible risk of an incident to occur.

Table 3-2 Historical Depths of MEC and MD Identified, All Proposed MRSs

Munition	Classification	Proposed MRS-01 Depth Range (inches)	Proposed MRS-02 Depth Range (inches)	Proposed MRS-03 Depth Range (inches)	Proposed MRS-04 Depth Range (inches)	Proposed MRS-05 Depth Range (inches)	Proposed MRS-06 Depth Range (inches)	Proposed MRS-07 Depth Range (inches)	Proposed MRS-08 Depth Range (inches)
105 mm (MK1, HE)	MEC	--	--	--	Surface	Surface	UNK	UNK	Surface
155 mm (projectile, rotating band)	MEC/MD	UNK	--	--	3 (0 / 1)	UNK	UNK	UNK	UNK
2.36-inch rocket	MEC	--	--	--	3-6 (0 / 3)	3	3-6	--	--
2.36-inch rocket warhead	MEC	--	--	--	UNK	--	--	2 (0 / 1)	UNK
3.25-inch Target Rocket	MD	30 (0 / multiple)	--	--	--	--	--	--	--
30 mm HE projectile (expended)	MD	3 (0 / 1)	--	--	--	--	--	--	--
37 mm projectile	MEC/MD	2-6 (0 / 1)	--	2-6 (0 / 2)	2-6 (2 / 10)	2-6 (1 / 0)	2-6 (0 / 6)	2-6	UNK
40 mm projectile (expended)	MD	--	--	--	--	6	UNK	UNK	--
57 mm projectile	MEC	Surface	--	--	--	--	UNK	UNK	UNK
57 mm projectile (AP-T, HE)	MD	6-14 (0 / 1)	--	6-14 (0 / 1)	--	6-14 (0 / 1)	6-14 (0 / 1)	6-14 (2 / 1)	--
60 mm HE mortars	MEC	0-1 (0 / 2)	--	--	--	--	--	--	--
60 mm Mortar	MEC	--	--	--	6-8	UNK	UNK	--	6-8
60 mm mortar (fins, frag, tail boom, expended fuze)	MD	0-12 (0 / 75)	0-12 (0 / 2)	--	--	--	--	--	--
75 mm projectile (base)	MD	6 (0 / 1)	--	UNK	--	--	UNK	--	UNK
81 mm Mortar	MEC/MD	--	--	--	0-32	UNK	0-32	--	0-32
81 mm mortar (fin, frag, tail boom)	MD	3-4 (0 / 6)	--	--	UNK	--	--	--	UNK
Grenade pins and spoons	MD	--	--	--	--	--	--	--	1-3 (0 / multiple)
Hand grenade	MEC	5-18 (3 / 0)	--	--	--	UNK	UNK	UNK	UNK
M1 Mine Spotting Charge	MEC	--	--	--	--	--	--	--	2-3
M1A1 Mine and Practice Landmine	MEC/UXO/MD	--	--	--	--	--	--	--	0-12
M1A1 Smoke Cartridge	MD	--	--	--	--	--	--	--	0-6
M9 Rifle Grenade	MEC	UNK	--	--	--	UNK	UNK	--	3
MKII HE Hand Grenade	MEC	--	--	--	--	4	--	--	--
Rifle grenade (illumination-spent, frag)	MD	2-6 (0 / 6)	--	--	UNK	--	--	--	--
Slap flare	MD	1	--	--	--	--	--	--	--
Smoke Grenade (expended)	MEC	--	--	--	--	--	--	--	Surface
Smoke Grenade frag	MD	--	--	--	--	--	--	--	0-8
Smoke Pot	MEC	--	--	--	--	--	--	--	3
T-bar fuze	MD	0-23 (0 / 15)	--	--	0-23 (0 / 2)	0-23 (0 / 7)	--	--	--
Unknown Frag	MD	0-40 (0 / 2,032)	0-40 (0 / 11)	0-40 (0 / 16)	0-40 (0 / 1,734)	0-40 (0 / 399)	0-40 (0 / 369)	0-40 (0 / 7)	0-40 (0 / 81)
Unknown Mortar Frag (fins and booms)	MD	4-10	--	--	--	--	--	--	--
WP Grenade	MEC/MD	--	--	--	--	--	--	--	0-8

Data compiled using multiple data sets from historical investigations and the RI; nomenclature of munition and some depths are not verifiable based on limited data in the historic entries. UNK is listed for unknown depths.
Note: The lack of a specific munition in an MRS does not necessarily indicate the munition is not present, two distinct target areas exist within these MRSs Quantities of MEC and MD are given in parenthesis (MEC quantity / MD quantity)

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Table 3-3 DGM Depth of Detection Table, Munitions Items Identified in Each Proposed MRS

Munition Item	TDEM (EM61-MK2)	AGC Sensor (MetalMapper 2x2) Dynamic Mode (3ms)	
	NRL Typical Detection Depth* (in)	Forward Model detection depth** (in).	DOD Library ID
Hand Grenade	12	13.2	Grenade Hand MK2_BlossomPoint_TP79
M9 Rifle Grenade	N/A	14.4	Rifle Grenade M9A1_Eglin_73_002_11
37 mm, M63, M51	12.0	12.0	37mm Projectile M51_CL_83_002_11
40 mm, M677 (MK 19)	N/A	13.2	40mm Projectile Mk2_BP_57_001_11
57 mm, M306A1	N/A	19.2	57mm Projectile M70_BP_100_002_11
60 mm mortar, M49A2	24.0	16.8	60mm Mortar M49A2_BP_87_002_11
2.36" Rocket, M6A1	20.4	18.0	2.36-in Bazooka Warhead M6_Eglin_65_002_11
75 mm, M48	32.4	24.0	75mm Shrapnel Projectile Mk1 Shrapnel_29P_4_001_11
81 mm mortar, M43A1 (charge 8)	25.2	21.6	81mm Mortar M43A1_BPTEM_48_003_11
105 mm, M1 (charge 7)	45.6	28.8	105mm Projectile M1_BPTEM_82_001_11
155 mm, M107	58.8	32.4	155mm Projectile M107_BPTEM_103_001_11

AGC= advanced geophysical classification
DGM = digital geophysical mapping
in = inches
ms= millisecond
NRL = Naval Research Laboratory
TDEM = Time-Domain Electromagnetic
**MR-9155 EM61-MK2 Response of Standard Munitions Items, October 2008, Naval Research Laboratory.*
Depths indicated are for items centered under the coil at horizontal (worst case) orientation, 5 mV, EM61 Channel 2.
***Forward models generated using Geosoft's Oasis Montaj UX-Analyze module (v. 9.3.3) and the standard and full DOD 3ms Libraries. The detection threshold set at 0.76 mV/A (time gate 5 (0.134 ms) was based on the minimum response at one foot bgs of all 6 Library ID's for the 37mm M51 projectile, which is smaller than the M63 version. Sensor configuration was the "MetalMapper 2x2 3ms 19gates" at 0.26 m above ground level with the item in a horizontal, cross-line orientation. Of the multiple Library ID's for the same item (multiple measurements taken at various depths and orientations), the one with the smallest UXA_Size at time gate 5 was used for the forward model.*

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3.1.3 Summary of Institutional Analysis

3.1.3.1 Institutional analyses are prepared to support the development of institutional control (IC) strategies and plans of action as a munitions response alternative. These strategies rely on existing powers and authorities of government agencies to protect the public at large from potential MEC hazards. A review of government institutions and private entities that exercise jurisdiction over the project site and have the ability to enforce ICs was provided as Appendix C of the RI report (HGL, 2016).

3.1.3.2 The institutional analysis shows that entities with jurisdiction and ownership of the land within the boundary of the former Camp Butner is varied. There are approximately 1,100 separate parcels identified within former Camp Butner, with approximately 750 unique landowners, with some landowners owning multiple parcels. About 90 percent of the landowners are private citizens and 10 percent are government, corporate or municipal entities. The institutional analysis identified the entities with jurisdiction, authority, and funding control over the project site with regard to institutional controls and included the following entities:

- USACE;
- USEPA;
- North Carolina Department of Environmental Quality;
- Army National Guard / North Carolina National Guard;
- Butner Public Safety;
- Person County Sheriff's Office;
- Durham County Sheriff's Office;
- Granville County Sheriff's Office; and
- Multiple private landowners

3.2 GENERAL RESPONSE ACTIONS

3.2.1 GRAs describe broad classes of actions that satisfy RAOs. GRAs must be defined for the medium in question (i.e., impact berm surface) and if appropriate, for the extent (e.g., mass or volume) of the contamination.

3.2.2 The following GRAs have been identified for the MEC contamination at the MRSs:

- **Risk and Hazard Management – ICs or LUCs:** This GRA deters exposure to contamination and may include, but is not limited to, access and land use restrictions, and education. Access restrictions may include installing and maintaining fencing around controlled areas to prohibit entry. Voluntary landowner participation is necessary, as USACE does not have the authority to install fences or warning signs without landowner permission. Education programs would include posting warning signs, providing "3R" (Recognize, Retreat, and Report) munitions safety awareness training for landowners, and distributing fact sheets or pamphlets.
    - ICs such as: Deed notices, zoning ordinances, special use permits, and restrictions on excavation;

  - LUCs designed to prevent or limit exposure of receptors to MEC: LUCs can include education programs, pamphlets, or warning signs. Voluntary landowner participation is necessary, as USACE does not have the authority to install fences or warning signs without landowner permission. LUCs can be cost effective, reliable, and immediately effective, and can be implemented either alone or in conjunction with other remedial components. Inspections and monitoring typically are required to document the long-term effectiveness of LUCs. The administrative feasibility and cost to implement LUCs depend on site-specific circumstances.
  - Physical measures (engineering controls): Physical barriers and access restrictions are examples of engineering controls.
- **Remedial Action – Recovery:** This GRA includes physical removal of MEC to reduce its potential impact on the public and the environment. Detection process options examined were DGM, advanced classification, and analog identification of anomalies. Removal process options examined included, but were not limited to, hand excavation, mechanical excavation, and mechanical excavation of soils and sifting.
- **Remedial Action – Disposal:** This GRA implements physical measures to reduce the MEC hazard, such as MEC disposal via intentional detonation.

3.2.3 With the exception of the No Action alternative, the GRAs identified above may be combined to develop remedial action alternatives for the MRSs.

3.2.4 A remedial action alternative employs engineered approaches to reduce the TMV of contaminants in the subsurface, thereby preventing or minimizing exposure of receptors to MEC or chemical contamination that could pose an unacceptable MEC hazard. Physical removal methods are typically used to remove surface and subsurface MEC for disposal. The feasibility and cost to implement MEC excavation options can vary widely based on site-specific conditions and circumstances.

3.3 IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

3.3.1 Background

3.3.1.1 USEPA has established guidelines for the types of response actions that should be developed during the detailed analysis stage; they are listed in the NCP (40 CFR 300.430(a)(1)) and are summarized as follows:

- Use treatment to address the threats posed by a site, wherever practicable.
- Use engineering controls for low, long-term threats or where treatment is impracticable.
- Use a combination of methods, as appropriate, to achieve protection of human health and the environment.
- Use ICs to supplement engineering controls to prevent or limit exposure to hazardous substances, pollutants, or contaminants. The use of ICs shall not substitute for active response measures as the sole remedy unless such active measures are determined not to be practicable.
- Consider using innovative technologies.

3.3.1.2 NCP guidance further states that "the development and evaluation of alternatives shall reflect the scope and complexity of the remedial action under consideration" (40 CFR 300.430(e)). Land use is also a consideration in developing alternatives. This FS is being performed due to a future potential human health exposure pathway for MEC risk only. An initial list of remedial technologies was developed based on Version 4.0 of the *Remediation Technologies Screening Matrix and Reference Guide* produced by the Federal Remediation Technologies Roundtable (FRTR) (FRTR, 2007) and on USACE guidance (USACE, 2013). The FRTR is a consortium of government agencies that have worked to build a more collaborative atmosphere among federal agencies involved in hazardous waste site remediation. The remedial technologies identified are described below.

3.3.1.3 The general categories of technologies for detection of MEC, positioning systems, as well as technologies and methods for recovery, removal, and disposal of MEC, can initially be screened based on appropriateness and effectiveness as discussed below, and as presented in the sections below. The effectiveness of a particular technology is influenced by its technical and administrative feasibility, with factors such as availability of services, materials, and operational reliability considered. Site-specific conditions influence the range of technology options that are reasonable at a given project site. The response technologies for detection, removal and disposal of MEC, and their respective individual process options, are evaluated with regard to site conditions.

3.3.2 Potentially Applicable Technologies

3.3.2.1 Land Use Controls

3.3.2.1.1 The three types of LUCs defined by Defense Environmental Restoration Program (DERP) include physical, legal, and administrative controls. The DERP Manual (DoD, 2012) gives the following descriptions of the LUCs types:

- Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and physical barriers to limit access to property;
- Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices; and
- Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting, education that helps modify or guide human behavior at a site, or other land use management systems to ensure compliance with the use restrictions.

3.3.2.2 MEC Detection Technologies

3.3.2.2.1 A number of effective technologies exist for detection of MEC, with some supported by subsets of systems for transport, positioning and navigation, and data processing and analysis. Information on the capabilities of existing technologies will be balanced against site-specific conditions throughout the MRSs to screen out approaches that are not suitable. This section evaluates geophysical and positioning technologies for MEC detection using summary information for each method from the USACE Technical Guidance for Military Munitions Response Actions, Interim Guidance Document Engineering Manual 200-1-15 (USACE, 2015).

3.3.2.2.2 Detection of MEC on the surface or in the subsurface can be accomplished using analog or digital methods. In the munitions response industry, analog methods refer to the use of handheld detector technologies operated by UXO technicians to identify anomalies (mag and count, mag and dig). Digital methods refer to digital geophysical mapping (DGM) in which detector signals and measurement locations (coordinates) are digitally recorded during the survey effort to create a permanent record of the survey. When MEC is located on the ground surface analog methods are appropriate, such as a detector-aided visual search by UXO technicians. When MEC is present in the subsurface DGM is most appropriate; however, analog methods may be necessary in areas of treacherous terrain where no other geophysical method is feasible. Per the DoD information Quality Guidelines (February 10, 2003) the level of quality necessary for influential scientific data requires that such information be capable of being substantially reproduced. This means all geophysical mapping should be acquired using digital methods that record geophysical measurements and their geodetic locations whenever possible.

3.3.2.2.3 Advanced Geophysical Classification (AGC) is a digital method by which data is used to estimate the intrinsic properties of a buried metal object; specifically, for munitions response and UXO removal, to determine whether the object is a target of interest (TOI) that must be removed or other non-explosive debris (non-TOI) that can be left in the ground. On April 11, 2016, the Assistant Secretary of Defense (Energy, Installations, and Environment) established the DoD Advanced Geophysical Classification Accreditation Program (DAGCAP), requiring the DoD Components to use DAGCAP accredited organizations for AGC work. Per FUDS Guidance Memo (April 2017), USACE is directed to utilize AGC methods to the maximum extent practical for all FUDS MMRP projects.

3.3.2.2.4 With regards to environmental characteristics detector and positioning technologies and the specific equipment used have inherent advantages and disadvantages based on their design and operational characteristics. Detector technologies commonly used for terrestrial applications in the munitions response industry include magnetometry and electromagnetic induction (EMI). Common positioning technologies / methods include global positioning systems (GPS), relative coordinates (wheel counter mode (odometer), line and fiducial), and laser-based technologies such as robotic total station (RTS). Positioning technologies are impacted primarily by obstacles (trees, structures), canopy (tree cover), and topography.The most applicable detection technologies for the MRSs at Camp Butner are described in Table 3-4. The technologies/applications described in Table 3-4 are screened against three criteria (Effectiveness, Implementability, and Cost) and only represent technologies / methods that have been successfully implemented at Camp Butner and other munitions response sites with similar objectives and environmental characteristics.

3.3.2.2.5 The most applicable detection technologies for the MRSs at Camp Butner are described in Table 3-4. The technologies/applications described in Table 3-4 are screened against three criteria (Effectiveness, Implementability, and Cost) and only represent technologies / methods that have been successfully implemented at Camp Butner and other munitions response sites with similar objectives and environmental characteristics.

Table 3-4 Detection Technologies and Applications

Technology / Application	Effectiveness	Implementability	Cost	Representative Equipment	Notes	Feasibility at Camp Butner
Analog (detector-aided surface clearance, mag and dig) – handheld magnetic gradiometer: Magnetic gradiometers measure the intensity of the vertical magnetic gradient of the earth's magnetic field along the instrument axis.	**Low to Medium:**Handheld gradiometers have been used as the primary detector in traditional surface clearance and mag and dig operations. High industry familiarization. Metal objects need to be ferrous (iron bearing) to be detectable. Results are operator dependent and Probability of detection (Pd) ranges between 50% and 72% in all instances where site conditions were suited to the sensor's capabilities.	**High:** Light and compact. Can be used in any traversable terrain. Costs, transportation, and logistics requirements are equal to or less than other systems. Widely available from a variety of sources. Minimal to no impacts to cultural or natural resources.	**Equipment (Low):** Most handheld gradiometers have a low cost for purchase and operation compared to other detector technologies / systems. **Application (Low to High):** Production estimates for mag and dig can be highly variable based on anomaly density and depth of clearance necessary. All "hits", regardless of signal intensity, are investigated. Due to the nature of analog methods, seeding requirements are siginifant.	Schonstedt 52- CX Schonstedt 72-CX Chicago Steel Tape (Magna-Trak 102) Foerster FEREX 4.032 Foerster FEREX 4.032 DLG Ebinger MAGNEX 120 LW Vallon (EL 1302D1,1303D)	Audible sound and / or visual meter output not usually co-registered with position data. Operator is part of detector system and results are more subjective than DGM. Requires rigorous QC and QA program. No permanent digital record of survey results.	**High (surface clearance):** Proven effective during past investigations at Camp Butner (anomaly avoidance, surface clearance). **Low-Medium (mag and dig):** Results are operator dependent and Probability of detection (Pd) ranges between 50% and 72% in all instances where site conditions were suited to the sensor's capabilities. This techology shold be limted in use for subsurface clearance to only those areas where digital mapping is not possible as it does not meet industry requirements for digital mapping and record.
Analog (detector-aided surface clearance, mag and flag) – handheld all metals detector: Frequency Domain EMI (FDEMI) and Time Domain EMI (TDEMI) handheld all metals detectors employ a primary magnetic field and measure the secondary magnetic field generated by subsurface metallic objects.	**Low to Medium:** Handheld all metal detectors have been used as the primary detector in traditional surface clearance and mag and dig operations. High industry familiarization. Detects all metal objects (ferrous and non-ferrous). Results are operator dependent and Probability of detection (Pd) ranges between 50% and 72% in all instances where site conditions were suited to the sensor's capabilities.	**High:** Generally light and compact. Can be used in any traversable terrain. Costs, transportation, and logistics requirements are equal to or less than other systems. Widely available from a variety of sources. Minimal to no impacts to cultural or natural resources.	**Equipment (Low):** Most all metals detectors have a low cost for purchase and operation compared to other detector technologies / systems. **Application (Low to High):** Production estimates for mag and dig can be highly variable based on anomaly densityand depth of clearance necessary. All "hits", regardless of signal intensity, are investigated. Due to the nature of analog methods, seeding requirements are siginifant.	Schiebel ANPSS-12 White's (various models) Garrett (various models) Fisher 1266X Foerster Minex Minelab Explorer II Minelab UXO Vallon (various models)	Audible sound and / or visual meter output not usually co-registered with position data. Operator is part of detector system and results are generally more subjective than DGM. Requires rigorous QC and QA program. No permanent digital record of survey results. Some systems are programmable to accept / reject certain types of metal.	**High (surface clearance):** Proven effective during past investigations at Camp Butner (anomaly avoidance, surface clearance). **Low-Medium (mag and dig):** Results are operator dependent and Probability of detection (Pd) ranges between 50% and 72% in all instances where site conditions were suited to the sensor's capabilities. This techology shold be limted in use as it does not meet industry requirements for digital mapping and record

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Table 3-4 Detection Technologies and Applications (continued)

Technology / Application	Effectiveness	Implementability	Cost	Representative Equipment	Notes	Feasibility at Camp Butner
Digital (DGM using Digital Optically Pumped Magnetometers): This technology is based on the theory of optical pumping and operates at the atomic level as opposed to the nuclear level (as in proton precession magnetometers).	**Medium to High:** Digital magnetic technology (optically pumped) is the industry standard for MEC detection when data are digitally recorded and processed / analyzed. High industry familiarization. Only detects ferrous metallic objects. Can be limited by terrain, vegetation, and magnetic soils / geology. Pd up to 100% for larger MEC where site conditions were suited to the sensor's capabilities. Pd lower for smaller items.	**Medium to High:** Equipment is digital, ruggedized, and weather resistant. Common systems weigh more than most handheld systems and are affected by heading error. Can be used in most terrain. Widely available from a variety of sources. Processing and interpretation requires trained specialists. Anomaly classification possibilities are limited by positional accuracy, magnetic susceptibility/magnetic moment estimates, and depth estimates. Detection capabilities are negatively influenced by iron-bearing soils. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection. Requires near surface vegetation clearance to achieve high quality data and achieve coverage metrics in grid applications.	**Equipment (Average to High):** Relatively high purchase cost compared to handheld sensors. **Application (Low to Average):** Production estimates independent of anomaly density; in areas of low and medium anomaly density "depth of detection" usually avoids need to excavate in lifts. Data analysis can minimize need to dig all anomalies.	Geometrics G-858 Geometrics G-822 Geometrics G-858 arrays Gem Systems GSMP - 40 Scintrex Smart Mag G-Tek TM4	Sensor arrays can be used to increase productivity in "open" areas.	**Medium to High**, although has not been used in previous investigations.
Digital (DGM using Time-Domain Electromagnetic Induction (TDEMI) Metal Detectors: TDEMI is a technology used to induce a pulsed electromagnetic field beneath the Earth's surface with a transmitter coil, which in turn causes a secondary magnetic field to emanate from nearby objects that have conductive / magnetic properties.	**High:** TDEMI technology is the industry standard for MEC detection when data are digitally recorded and processed / analyzed. High industry familiarization. Detects both ferrous and non-ferrous metallic objects. Can be limited by terrain, vegetation, and highly magnetic soils / geology. Pd frequently 100% where site conditions were suited to the sensor's capabilities.	**Medium to High:** Equipment is digital, ruggedized, and weather resistant. Sensors and platforms are generally larger than handheld systems and digital magnetometers. Can be used in most terrain. Available from a variety of vendors. Simplistic anomaly classification possible for multi-channel systems. Processing and interpretation requires trained specialists. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection. Requires near surface vegetation clearance to achieve high quality data and achieve coverage metrics in grid applications.	**Equipment (Average to High):** Relatively high purchase cost compared to handheld sensors. **Application (Low to Average):** Production estimates independent of anomaly density; in areas of low and medium anomaly density "depth of detection" usually avoids need to excavate in lifts. Data analysis can minimize need to dig all anomalies.	Geonics EM61 Geonics EM61-MK2, MK2 HP Geonics EM61-MK2 HH EM61-MK2 arrays Geonics EM63 Zonge Nanotem G-Tek TM5	Sensor arrays can be used to increase productivity in "open" areas. Zonge Nanotem and G-Tek TM5 have very limited supply, require specialized training and software for initial stages of data conversion and processing; relatively lower industry familiarization compared to Geonics TDEMI family of sensors.	**High –** DGM using Geonics family of TDEMI sensors has been successfully applied at Camp Butner.

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Table 3-4 Detection Technologies and Applications (continued)

Technology / Application	Effectiveness	Implementability	Cost	Representative Equipment	Notes	Feasibility at Camp Butner
Digital (Advanced Geophysical Classification (AGC) using TDEMI Metal Detectors:	**High:** All systems can collect dynamic and static (cued) measurements to record entire EMI response pattern. Greatest ability of all sensors for the classification of anomalies as either TOI or non-TOI. Detects both ferrous and non-ferrous metallic objects. Pd 100% in all instances where site conditions were suited to the sensor's capabilities.	**Medium to High:** MetalMapper™, TEMTADS large array, BUD, and ALLTEM require the use of a vehicle to tow the sensors and electronics. MPV, Temtads 2X2, Metal Mapper 2X2, and Handheld BUD are person portable. Sensor and platform size limits accessibility in steep terrain or areas with numerous obstacles (trees). Person-portable systems have the same general accessibility as person-portable FDEMI and TDEMI sensor systems.	**Equipment (Average – High):** Relatively high purchase cost compared to handheld and other digital sensors. **Application (Low):** The significant decrease in intrusive investigation costs due to leaving non-TOI in the ground results in lower overall costs, and more than offsets the additional data collection and processing / analysis costs.	MetalMapper™ Metal Mapper 2x2 TEMTADS 2x2 MPV TEMTADS towed array BUD OPTEMA Handheld BUD	MetalMapper 2x2 and MPV are in production and readily available. Other systems have limited availability. The Department of Defense Advanced Geophysical Classification Accreditation Program (DAGCAP) requires accreditation to perform AGC and currently eleven companies are certified.	**High** - AGC has been successfully demonstrated at Camp Butner. FUDS Guidance Memo (April 24, 2017) states that AGC is the preferred method of geophysical data collection for FUDS munitions response activities.

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3.3.2.3 Positioning Systems

3.3.2.3.1 Several effective positioning systems/technologies exist that can be easily integrated with most of the digital detection technologies referenced in Table 3-4.

Differential GPS

3.3.2.3.2 Real time kinematic (RTK) GPS requires a known survey point (or subscription service) and is very effective in "open" areas (areas without canopy or tall tree lines) for both digital mapping and reacquiring anomalies. Centimeter accuracy / precision. (Effectiveness: High).

Robotic Total Station (RTS)

3.3.2.3.3 RTS requires an existing network of control points and is generally line of sight. Somewhat limited by distance, atmospheric conditions, and the presence of extensive numbers of obstacles (trees). RTS systems are effective in areas of canopy that have a low to medium number of obstacles (trees) for both digital mapping and reacquiring anomalies. Centimeter accuracy / precision. (Effectiveness: Medium to High)

Fiducial Positioning / Odometer

3.3.2.3.4 Fiducial positioning involves the placement of markers in the DGM data stream when the sensor platform crosses known, predefined locations. The technique requires relatively high level of operator experience, detailed note taking, and the need for maintaining a constant pace along a "straight" line. Does not produce a digital record of the operator's actual travel path during data collection. (Effectiveness: Medium)

3.3.2.4 DGM Platforms

3.3.2.4.1 The primary platforms for the digital technologies reviewed in Table 3-4 include person-portable, person-portable wheel mode, person-portable litter carry, and the vehicle towed application. All detector technologies are not designed to be used on different platforms, and ruggedized platforms supplied by the manufacturer are usually very limited. The weight, size, and design of the sensor / platform and electronic components supplied by the manufacturer should be assessed in terms of ergonomics for longer term projects (several weeks or more). Integration of positioning systems / methods are largely the responsibility of the end user.

Person-portable

3.3.2.4.2 Sensor and electronics can be transported in most terrain by one or two operators. Sensor height above the ground surface is flexible and controlled by instrument operator(s). Variations in sensor height can be caused by terrain and fatigue. **(Effectiveness: Medium to High)**

Person-portable wheel mode

3.3.2.4.3 Sensor and electronics placed on wheeled platform supplied by manufacturer, or a platform designed and built by the end user. Can be transported in most terrain by one or two

operators. Sensor height above the ground surface is fixed and maintained by platform. Generally, less operator fatigue for most technology / applications compared to person-portable or person-portable litter carry. **(Effectiveness: High)**

Person portable litter carry

3.3.2.4.4 Sensor and electronics distributed on platform constructed by end user. Requires a minimum of two operators. Sensor height above the ground surface is flexible and controlled by instrument operator(s). Variations in sensor height can be caused by terrain and fatigue. **(Effectiveness: Medium to High)**

Vehicle towed

3.3.2.4.5 Sensor and electronics distributed on platform constructed by end user and towed with appropriate vehicle. Multiple sensors usually combined as an array of sensors to increase productivity. Sensor height above the ground surface is fixed and maintained by platform. Optimum use in "open" areas with limited or no obstacles. Significantly less operator fatigue compared to person-portable, person-portable wheel mode, and person-portable litter carry. **(Effectiveness: High)**

3.3.2.4.6 Detection and positioning system technologies/applications generally not applicable for remedial activities at Camp Butner are summarized in Table 3-5.

Table 3-5 DGM Platform Technologies and Applications Not Likely Applicable

Technology / Application	Primary Limitation(s)
Airborne DGM - Detection	Flying height restrictions due to expansive vegetation in project area (significant reduction of sensitivity to MEC items of interest)
Airborne spectral imaging - Detection	Limited resolution to resolve munitions items of interest, especially when items present below the ground surface
Airborne radar (synthetic aperture) - Detection	Limited resolution to resolve munitions items of interest, especially when items present below the ground surface
Sub audio magnetics (SAM) - Detection	Very limited equipment availability and low industry familiarization
Magnetometry / TDEMI Dual Array - Detection	Very limited system availability
Ground penetrating radar (GPR) - Detection	Severely limited penetration of signal in conductive / magnetic soils; data processing and analysis complex and time consuming. Non-unique solution.
Digital magnetometers (Proton precession and Overhauser) - Detection	Lower sensitivity and data recording rates compared to optically pumped magnetometer technology
Ultrasonic Ranging and Detection System (USRADS) - Positioning	Very limited equipment availability and low industry familiarization
Constellation (laser) - Positioning	Very limited equipment availability and low industry familiarization; equipment not ruggedized for outdoor use

3.3.2.5 Recovery Technologies

Hand Excavation

3.3.2.5.1 Hand excavation can be accomplished in most terrain, and is limited only by the number of available UXO-qualified technicians. Hand removal is labor intensive, and can be very difficult and time consuming in soil that is very hard or for items that are very deep (greater than 3 ft). It can also be very time consuming in areas with concentrated MD. **(Effectiveness: High)**

Mechanized Removal of Individual Anomalies

3.3.2.5.2 Heavy equipment is readily available on an as-needed basis to supplement hand-digging. This approach is useful in areas of hard soil and substantial metal concentrations. **(Effectiveness: High)**

Mass Excavation and Sifting

3.3.2.5.3 Mass excavation and sifting requires armoring of heavy equipment. Such specialized armor is not readily available, and is therefore not easily implementable. **(Effectiveness: Low)**

3.3.2.6 Disposal Technologies

3.3.2.6.1 The disposal process involves three components, including (1) removal and elimination of the explosive hazard, (2) treatment of MEC residue and scrap, and, if necessary, elimination of any remaining MC, and (3) final disposition of MD. Future contractors should also consider the use of piercing charges for BIP operations in coordination USACE safety personnel.

Blow-In-Place

3.3.2.6.2 Blow-in-place (BIP) involves the in-place destruction of MEC by explosive detonation. BIP is the most widely used method of MEC disposal. It is both highly effective and implementable. Although BIP operations often require added security and engineering controls to protect the public in proximity to the site, the location of the MRSs allows for such measures. **(Effectiveness: High)**

Consolidate and Detonate

3.3.2.6.3 Consolidate and detonate involves the collection, configuration, and subsequent destruction of MEC by explosive detonation. The consolidation point is located either at a designated disposal location, or from a designated point within the site in which an item was found. The option is very effective, and is considered to have a medium to high factor of implementability. **(Effectiveness: High)**

Laser Initiation

3.3.2.6.4 Laser initiation involves the use of a vehicle-mounted laser at a safe distance to apply heat sufficient to bring an item to detonation or conflagration temperatures. Both the effectiveness and implementability of this process are considered to have a low ranking. **(Effectiveness: Low)**

Portable Contained Detonation Chambers (CDC)

3.3.2.6.5 Use of the CDC method involves transport of acceptable to move items to a fixed or portable CDC. The portable CDC is highly effective in disposing of items with a net explosive weight of up to approximately 35 pounds. This option requires long-distance transport of the CDC to the site. **(Effectiveness: Low)**

Disassembly or Render Safe Procedures

3.3.2.6.6 Disassembly or render safe procedures, which can only be administered by an explosives ordnance disposal professional, are the procedures that enable the neutralization and/or disarming of mines and munitions to occur in a recognized and safe manner. This approach has a medium probability of success versus other options, but exposes personnel to significant danger as compared to other options. **(Effectiveness: Low)**

MEC Residual Processing

3.3.2.6.7 MD cannot leave the site until it is certified as 100 percent inspected and is, to the best of the contractor's knowledge, inert or free of explosive hazards, illuminating dials, and visible liquid hazardous, toxic, and radioactive waste materials. The Senior Unexploded Ordnance Supervisor (SUXOS) and UXO Quality Control Specialist (UXOQCS) must make independent final inspections of MD, and complete and sign a Form 1348-1A as turn-in documentation. If on-

site MEC disposal/destruction results in detectable MC in the MEC residual waste stream, the remaining MC must be removed before scrap material can be released for off-site recycling.

Final Disposition of MD

3.3.2.6.8 After being inspected and certified as being free of explosives hazard, MD may be shipped to a metal smelter. **(Effectiveness: High)**

3.3.3 Technology Evaluation

3.3.3.1 Screening level evaluation of remedial technologies included evaluation of the effectiveness, implementability, and cost of each technology. The identified technologies retained for consideration and detailed analysis are summarized in Figure 3.1. Relative cost information for technology screening represents the technology cost only (implementation and operation), not the overall remedial cost to achieve a cleanup objective. All identified technologies retained for consideration are deemed effective, implementable, and practical based on their cost.

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4.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

4.1 DEVELOPMENT OF ALTERNATIVES

4.1.1 Introduction

4.1.1.1 Based on the RAO for the MRSs, the GRAs, and available detection, removal, and disposal technologies and process options for MEC, the remedial technologies retained after the technology evaluation (Figure 3.6) were assembled into the following remedial action alternatives:

- Alternative 1: No Action
- Alternative 2: LUCs (Public Education and Signs)
- Alternative 3: Surface Clearance with Analog Detection Methods, and LUCs
- Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Methods (UU/UE Method A)
- Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

4.1.1.2 Five-year reviews, as outlined in Section 121(c) of CERCLA, as amended by the Superfund Amendments and Reauthorization Act, and Section 300.430 (f) (ii) of the NCP, are required for sites (at least every 5 years) where hazardous substances, pollutants, or contaminants remain above levels that allow UU/UE following implementation of the remedy.

4.1.2 Alternative Descriptions

4.1.2.1 Alternative 1: No Action

4.1.2.1.1 The No Action alternative means that a remedy will not be implemented to reduce MEC that potentially remains at the site. No action would be taken to remove MEC, and these items would continue to present an explosive hazard. This alternative, if implemented, would involve continued use of the site in its current condition. No Action is included as a baseline alternative in this FS for comparison with the remaining alternatives.

4.1.2.2 Alternative 2: LUCs

4.1.2.2.1 To educate the public of potential MEC hazards, one educational pamphlet would be developed, then the appropriate number of pamphlets (based on the number of landowners and other stakeholders) would be printed and distributed to convey information about the potential presence of MEC within the MRSs and the necessary safety precautions to be taken to enter the areas of identified MEC contamination. These pamphlets would be mailed to all residents. Pamphlets would also be made available to site workers, school children, visitors/recreational users, and other personnel who are known to access the site. Signs would also be placed within DOT easements along primary roads in the MRSs (similar to the EE/CA removal action) to inform site users of the potential hazards at the site.

4.1.2.2.2 Data may be gathered during the review process to determine if further action needs to be taken to protect public safety and the human environment. Data gathered will include local law

enforcement reports of citizen-reported MEC, interviews with distributors of public education pamphlets to evaluate public interest, etc. If no changes have taken place, the site would continue to be monitored and inspected at the specified intervals (typically annually). The components of this alternative are summarized in Table 4-1.

Table 4-1
Alternative 2 Description

Alternative 2	Important Actions
Educational Pamphlets	Development and distribution of an educational pamphlet to convey information on the potential presence of MEC within the proposed MRSs and the necessary safety precautions to be taken to enter the area.
Signage	Installation of signs in and around the proposed MRSs to warn site users/visitors of the hazards potentially present at the site. Installation of approximately 50 signs is assumed, with 10% replacement required annually.
Description of Alternative 2, as Applicable to each proposed MRS	
Proposed MRS-01	1,429 acres, development of 1,000 pamphlets and 50 signs.
Proposed MRS-02	391 acres, development of 1,000 pamphlets and 50 signs.
Proposed MRS-03	924 acres, development of 1,000 pamphlets and 50 signs.
Proposed MRS-04	2,202 acres, development of 1,000 pamphlets and 50 signs.
Proposed MRS-05	1,807 acres, development of 1,000 pamphlets and 50 signs.
Proposed MRS-06	1,451 acres, development of 1,000 pamphlets and 50 signs.
Proposed MRS-07	1,385 acres, development of 1,000 pamphlets and 50 signs.
Proposed MRS-08	1,179 acres, development of 1,000 pamphlets and 50 signs.

Note: number of pamphlets intended for distribution at elementary schools, libraries, and other public education events. Number of signs estimated from landowner participation rates in the past.

4.1.2.3 Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

4.1.2.3.1 Alternative 3 would consist of three components: (1) conducting a surface clearance of MEC over the proposed MRS utilizing analog detection methods; (2) developing and distributing educational pamphlets as described in Alternative 2 and (3) installing signage as described in Alternative 2.

4.1.2.3.2 The primary component of Alternative 3 is surface clearance removal of MEC from the MRSs. Surface clearance of MEC at the project site would result in a reduction in accessible MEC hazards; however, MEC may remain within the MRS.

4.1.2.3.3 Field tasks associated with Alternative 3 would include surveying, vegetation clearance, surface clearance, investigation and removal of anomalies potentially representing MEC using analog magnetometers, and disposal of any MEC, material potentially presenting an explosives hazard (MPPEH), or MD. Vegetation cutting/clearance would only be conducted where necessary to complete MEC clearance operations. Surface clearance would be completed by qualified UXO technicians using analog magnetometers, such as the Schonstedt GA-52Cx, or equivalent.

4.1.2.3.4 For the purposes of cost estimation, this alternative assumes that there would be seven clearance teams composed of two UXO Technician IIs, and one UXO Technician III (team leader) each, with oversight provided by one SUXOS, one UXOQCS, and one UXO Safety Officer (UXOSO) completing the work over 40-hour workweeks.

4.1.2.3.5 MEC items encountered during the clearance would be BIP. If acceptable to move, MEC items would potentially be consolidated for demolition. It is assumed that on-call explosives would be used for one demolition event per week of investigation. MEC items would be guarded by an unarmed security guard during nonworking hours. All MD recovered would be inspected, verified, certified as material documented as safe (MDAS), containerized, and shipped to an approved off-site facility for disposal. All areas disturbed during the MEC clearance would be restored and re-seeded.

4.1.2.3.6 Similar to Alternative 2, educational pamphlets would be developed and distributed, and signs would be installed in and around the MRSs. The components of this Alternative 3 are summarized in Table 4-2.

Table 4-2
Alternative 3 Description

Alternative 3	Important Actions
Surface Clearance of MEC with Analog Detection Methods, and LUCs	Surveying, vegetation clearance (only where necessary), surface clearance and removal of MEC with analog magnetometers, and disposal of any MEC, MPPEH, and MD.
Educational Pamphlets	Development and distribution of an educational pamphlet (1,000 copies per MRS) to convey information on the potential presence of MEC within the proposed MRSs and the necessary safety precautions to be taken to enter the area.
Signage	Installation of signs in and around the proposed MRSs to warn site users/visitors of the hazards potentially present at the site. Installation of approximately 50 signs is assumed, with 10% replacement required annually.
Description of Alternative 3, as Applicable to each proposed MRS	
Proposed MRS-01	1,429 acres
Proposed MRS-02	391 acres
Proposed MRS-03	924 acres
Proposed MRS-04	2,202 acres
Proposed MRS-05	1,807 acres
Proposed MRS-06	1,451 acres
Proposed MRS-07	1,385 acres
Proposed MRS-08	1,179 acres

4.1.2.4 Alternative 4: Surface and Subsurface Removal of MEC to the Depth of Detection Using DGM Detection Methods (UU/UE Method A)

4.1.2.4.1 Alternative 4 would include conducting surface clearance and subsurface removal of MEC to the depth of detection over the proposed MRSs with DGM methods. This alternative would accomplish UU/UE for the MRSs defined as: Alternative 4 is anticipated to achieve UU/UE based on the current site conditions and the completion of removal of MEC to the depths of detection identified for each munition type, in each proposed MRS, as shown on Table 3-2. The depths that MPPEH is detected and removed will be evaluated post-removal to verify that UU/UE is achieved.

4.1.2.4.2 The primary component of Alternative 4 is surface clearance and subsurface removal of MEC from the proposed MRSs. Surface clearance and subsurface removal of MEC at the proposed

MRS would result in a significant reduction in accessible MEC hazards; however, MEC may remain within the proposed MRSs.

4.1.2.4.3 Field tasks associated with Alternative 4 would include professional land surveying, vegetation clearance, surface clearance, DGM surveying, intrusive investigation and removal of all anomalies potentially representing subsurface MEC to depth of detection and disposal of any MEC, MPPEH, or MD. Vegetation cutting/clearance would only be conducted where necessary to complete MEC clearance operations. Subsurface investigations would be completed by qualified UXO technicians to the depth of instrument detection. All anomalies identified that exceed a certain millivolt threshold would be excavated until the source of the anomaly is found. Additionally, 100 percent coverage of the proposed MRSs would be attempted. Surface clearance and subsurface removal of MEC at the project site would result in a significant reduction in accessible MEC hazards.

4.1.2.4.4 For the purposes of cost estimation, this alternative assumes that there would be seven clearance teams each composed of multiples of UXO Technician Is and UXO Technician IIs, led by UXO Technician III (team leader), with oversight provided by one SUXOS, one UXOQCS, and one UXOSO completing the work over 40-hour workweeks.

4.1.2.4.5 MEC items encountered during the clearance would be BIP. If acceptable to move, MEC items would potentially be relocated for demolition. It is assumed that on-call explosives would be used for one demolition event per week of investigation. MEC items would be guarded by an unarmed security guard during nonworking hours. All MD recovered would be inspected, verified, certified as MDAS, containerized, and shipped to an approved off-site facility for disposal. All areas disturbed during the MEC clearance would be restored and re-seeded.

4.1.2.4.6 Surface clearance and subsurface removal of MEC under this alternative would allow UU/UE. No further action would be required to protect receptors and no LUCs are included. The components of this Alternative 4 are summarized in Table 4-3.

Table 4-3
Alternative 4 Description

Alternative 4	Important Actions
Surface and Subsurface Removal of MEC	Surveying, vegetation clearance, surface clearance and subsurface removal of MEC to the depth of instrument detection, utilizing DGM/dynamic advanced sensor methods, and disposal of any MEC, MPPEH, and MD.
UU/UE Definition	Alternative 4 is anticipated to achieve UU/UE based on the current site conditions and the completion of removal of MEC to the depths of detection identified for each munition type, in each proposed MRS, as shown on Table 3-2. The depths that MPPEH is detected and removed will be evaluated post-removal to verify that UU/UE is achieved.
Description of Alternative 4, as Applicable to each proposed MRS	
Proposed MRS-01	1,429 acres
Proposed MRS-02	391 acres
Proposed MRS-03	924 acres
Proposed MRS-04	2,202 acres
Proposed MRS-05	1,807 acres
Proposed MRS-06	1,451 acres
Proposed MRS-07	1,385 acres
Proposed MRS-08	1,179 acres

4.1.2.5 Alternative 5: Surface Clearance and Subsurface Removal of MEC to the Depth of Detection Using Advanced Classification Methods (UU/UE Method B)

4.1.2.5.1 Alternative 5 would include conducting a surface clearance and subsurface removal of MEC to the depth of instrument detection over all of the MRSs utilizing DGM/dynamic advanced sensor methods and Advanced Classification Methods. Alternative 5 is anticipated to achieve UU/UE based on the current site conditions and the completion of removal of MEC to the depths of detection identified for each munition type, in each proposed MRS, as shown on Table 3-2. The depths that MPPEH is detected and removed will be evaluated post-removal to verify that UU/UE is achieved.

4.1.2.5.2 Field tasks and personnel estimations would be equivalent to those identified for Alternative 4, with the exception that the removal of anomalies potentially representing subsurface MEC would be supplemented by Advanced Classification data to be gathered and intrusive investigation would be to the depth of instrument detection. The anomalies identified as targets of interest would be excavated until the source of the anomaly is found. Surface clearance and subsurface removal of MEC at the project site would result in a significant reduction in accessible MEC hazards. MEC items would be managed and disposed of similarly to what is described for Alternative 4. Additionally, vegetation cutting/clearance would only be conducted where necessary to complete MEC clearance operations, and MEC clearance areas would be restored and reseeded. Surface clearance and subsurface removal of MEC under this alternative would allow UU/UE. No further action would be required to protect receptors and no LUCs are included. The components of this Alternative 5 are summarized in Table 4-4.

Table 4-4
Alternative 5 Description

Alternative 5	Important Actions
Surface and Subsurface Removal of MEC	Surveying, vegetation clearance, surface clearance and subsurface removal of MEC to the depth of instrument detection, utilizing DGM/dynamic advanced sensor methods, and disposal of any MEC, MPPEH, and MD. Intrusive investigation will be reduced based on AGC classification methods.
UU/UE Definition	Alternative 5 is anticipated to achieve UU/UE based on the current site conditions and the completion of removal of MEC to the depths of detection identified for each munition type, in each proposed MRS, as shown on Table 3-2. The depths that MPPEH is detected and removed will be evaluated post-removal to verify that UU/UE is achieved.
Description of Alternative 5, as Applicable to each proposed MRS	
Proposed MRS-01	1,429 acres
Proposed MRS-02	391 acres
Proposed MRS-03	924 acres
Proposed MRS-04	2,202 acres
Proposed MRS-05	1,807 acres
Proposed MRS-06	1,451 acres
Proposed MRS-07	1,385 acres
Proposed MRS-08	1,179 acres

4.2 INITIAL SCREENING OF INDIVIDUAL ALTERNATIVES

4.2.1 This section discusses the relative performance of the remedial action alternatives described in Section 4.1 relative to identified screening criteria. The screening criteria include the following:

- **Effectiveness** – the degree to which an alternative reduces the toxicity, mobility, or volume of the hazardous substances through treatment; minimizes residual risks; and affords long-term protection.
- **Implementability** – the technical and administrative feasibility of implementing the alternative.
- **Cost** – the costs of construction and any long-term costs to operate and maintain.

4.2.2 The screening criteria presented above were used to screen each of the alternatives and to identify those alternatives that should be retained for further evaluation. Table 4-5 presents a summary of the screening process for the remedial action alternatives per proposed MRS. The detailed analysis and evaluation in Section 5 compares additional criteria for each of the alternatives. Section 5 also identifies the most practicable permanent solution as determined by the criteria specified in the NCP (40 CFR 300.430 *et seq*).

4.2.1 Alternative 1: No Action

4.2.1.1 This alternative does not provide long-term protection of human health and environment, as it does not implement any remedy to reduce potential risk. Implementation of this alternative would not meet the effectiveness screening criterion. No preliminary screening is necessary for this alternative, and this alternative is retained for detailed analysis in Section 5.0. The No Action alternative is applicable to all six recommended MRSs.

4.2.2 Alternative 2: LUCs

4.2.2.1 This alternative would restrict digging and minimize possible receptor interaction by providing warning of MEC presence, thus reducing the potential for receptor exposure. Signs can be effective in reducing access to an area but are dependent on the cooperation of landowners, government personnel, contractors, subcontractors, and authorized visitors for implementation and may prove too restrictive regarding future land use. An educational pamphlet would inform the public of potential MEC hazards and safety precautions to be taken to avoid contact with MEC. Costs would be low compared to other potential remedial alternatives.

4.2.2.2 Implementation is technically and administratively feasible, and the services and materials, such as pamphlets, signage, and website, necessary to implement are readily available. This alternative would provide warning to the general public, government personnel, contractors, subcontractors, or authorized visitors who unknowingly may encounter the site during their daily activities. A thousand pamplets per proposed MRS would be distributed to land owners, libraries, schools, county offices, etc. The signs would be installed in key locations at the MRS perimeter and in public easements if landowners refuse access. Long-term effectiveness would be maintained through sign maintenance. There would be no reduction of TMV through treatment of the hazardous substances as a result of Alternative 2. However, Alternative 2 would potentially reduce MEC hazards through education and warning signs, limiting intrusive activity and increasing public knowledge within the MRSs. This alternative is retained for further detailed analysis for all MRSs.

4.2.3 Alternative 3: Surface Removal of MEC Using Analog Detection Methods, and LUCs

4.2.3.1 This alternative would provide surface removal of MEC within the MRS using analog detection methods. Surface clearance of MEC at the selected project site would result in a reduction in accessible MEC hazards; however, MEC may remain on site in subsurface soils within the cleared area. An educational pamphlet would inform the public of potential MEC hazards and safety precautions to be taken to avoid contact with MEC, and warning signs would be installed in locations at the perimeter of the proposed MRSs.

4.2.3.2 Costs would include those for vegetation removal, surface removal of MEC within the MEC-contaminated areas, MEC disposal and MPPEH disposition, site restoration, signage installation, and development and distribution of an educational pamphlet. Alternative 3 would be effective at reducing the volume of MEC through surface removal or subsequent disposal; however, the amount of MEC removal would be reduced since most of the items found during the RI, previous investigations and removal actions were buried. This alternative is technically and administratively feasible for implementation and all services and materials necessary to implement are readily available but would require specialized personnel and equipment and detailed work plans. Alternative 3 would provide a partial reduction in MEC hazards through surface only removal of MEC and through education and warning signs for receptors entering the MRSs. This alternative is retained for detailed analysis for all MRSs.

4.2.4 Alternative 4: Surface and Subsurface Removal of MEC to the Depth of Instrument Detection Using DGM Detection Methods (UU/UE Method A)

4.2.4.1 This alternative would provide surface and subsurface removal of MEC to a depth of instrument detection within all of the MRSs by utilizing DGM/dynamic advanced sensor methods, and excavating all anomalies identified. Additionally, 100 percent coverage of the MRSs would be attempted but steep-sloped areas may prevent full coverage. Costs are the highest of all the alternatives. Implementation is technically and administratively feasible and would effectively reduce TMV but would require specialized personnel and equipment and detailed work plans. Costs would include those for vegetation removal, surface and subsurface clearance within the MEC contaminated areas, MEC disposal, and MPPEH disposition, site restoration. Surface and subsurface removal of MEC under this alternative would be to a depth protective of receptors associated with all of the MRSs. Long-term effectiveness would therefore be obtained. Consequently, RAOs for all of the MRSs would be met by implementing this alternative. Additionally, surface and subsurface removal of MEC under this alternative would reduce hazards associated with MEC within the MRS to an acceptable risk that would allow UU/UE. Alternative 4 meets all screening criteria; therefore, this alternative is retained for detailed analysis with regard to all of the MRSs.

4.2.5 Alternative 5: Surface and Subsurface Removal of MEC to the Depth of Instrument Detection Using Advanced Classification Methods (UU/UE Method B)

4.2.5.1 This alternative would provide surface and subsurface removal of MEC to a depth of instrument detection within all of the MRSs by utilizing DGM/dynamic advanced sensor methods, and excavating the targets of interest identified during AGC data evaluation. Additionally, 100 percent coverage of the MRSs would be attempted but steep-sloped areas may prevent full coverage. Costs are the second-highest compared to other alternatives. Implementation is technically and administratively feasible and would effectively reduce TMV but would require specialized personnel and equipment and detailed work plans. Costs would include those for vegetation removal, surface and subsurface clearance within the MEC contaminated area, MEC disposal, and MPPEH disposition, site restoration. Surface and subsurface removal of MEC under this alternative would be to a depth protective of receptors associated with all of the MRSs. Long-term effectiveness would therefore be obtained. Consequently, RAOs for all of the MRSs would be met by implementing this alternative. Additionally, surface and subsurface removal of MEC under this alternative would reduce hazards associated with MEC within the MRS to an acceptable risk that would allow UU/UE. Alternative 5 meets all screening criteria; therefore, this alternative is retained for detailed analysis with regard to all of the MRSs.

Table 4-5
Summary of Remedial Action Alternatives Screening for the MRSs

No.	Alternative Description	Proposed MRS-01	Proposed MRS-02	Proposed MRS-03	Proposed MRS-04	Proposed MRS-05	Proposed MRS-06	Proposed MRS-07	Proposed MRS-08	Major Components	Retained?
1	No Action	X	X	X	X	X	X	X	X	Required by NCP for comparison purposes only. No administrative controls required. No monitoring or removal of contaminated media would occur. No LUCs or educational programs would be implemented to control exposure to MEC.	Yes
2	LUCs	X	X	X	X	X	X	X	X	Utilizes administrative procedures/polices to control receptor exposure to contaminated media. No source reduction; therefore, no reduction of TMV through treatment Reduces the potential for exposure pathway completion and receptor interaction. Implementation is technically and administratively feasible, and the services and materials necessary to implement are readily available. Costs would be low.	Yes
3	Surface Clearance of MEC with Analog Detection Methods, and LUCs	X	X	X	X	X	X	X	X	Implementation is technically and administratively feasible. Some source reduction in MEC would be provided by surface only removal. Implementation would only provide long-term effectiveness in some areas through removal of surface MEC; MEC can potentially remain in the subsurface. Overall effectiveness of Alternative 3 is lower as compared to Alternative 4 and Alternative 5. Alternative 3 has a lower cost than Alternative 4 and Alternative 5.	Yes
4	Unlimited Use and Unrestricted Exposure (UU/UE) Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	X	X	X	X	X	X	X	X	Implementation is technically and administratively feasible. Costs would be high. Implementation would provide long-term effectiveness, and reduction of TMV through treatment, through the removal of surface and subsurface MEC contamination to depth of detection. All anomalies identified would be excavated, and 100 percent coverage of the MRSs would attempted.	Yes
5	UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	X	X	X	X	X	X	X	X	Implementation is technically and administratively feasible. Costs would be high. Implementation would provide long-term effectiveness, and reduction of TMV through treatment, through the removal of surface and subsurface MEC contamination to the depth of instrument detection. All targets of interest identified during AGC data evaluation would be excavated, and 100 percent coverage of the MRSs would attempted.	Yes
	Five-Year Reviews Only	X	X	X	X	X	X	X	X	Not considered as part of any alternative. Considered for MRSs where individual alternatives will not achieve UU/UE.	Yes

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5.0 DETAILED ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

5.1.1 This section presents a detailed analysis of the remedial action alternatives for the proposed MRSs. Remediation technologies were initially screened for appropriateness to site-specific conditions and reduced to a list of technologies relevant to these MRSs. The remedial alternatives developed in Section 4.1 were evaluated per each proposed MRS. Based on the screening process described in Section 4.2, those alternatives determined to be most appropriate for each proposed MRS were retained for detailed analysis. The following alternatives were retained for detailed analysis:

- Alternative 1: No Action
- Alternative 2: LUCs (Public Education and Signage)
- Alternative 3: Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs
- Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)
- Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

5.1.2 The alternatives are compared and evaluated with respect to seven evaluation criteria developed to address the statutory requirements and preferences of CERCLA. The seven criteria are as follows:

Threshold Factors: Threshold factors, such as protectiveness and compliance with ARARs, are requirements that each alternative must meet.

- Overall protection of human health and the environment: The selected alternative must adequately protect human health and the environment from unacceptable risks posed by MEC. The overall protectiveness to human health and the environment is evaluated based on the impact each alternative has on the exposure hazard (MEC) and environment. Although the potential for human receptors to come into contact with MEC at each proposed MRS is currently limited, the protectiveness criterion was evaluated in terms of possible future human interaction with contaminated soil. Exposure involves three components: the MEC source characteristics, the receptor, and interaction between them. All three components are required for a safety threat from MEC to exist. The protectiveness factor also considers the environmental impact that implementation of an alternative has on the existing environmental/ecological factors at each proposed MRS.
- Compliance with ARARs: The NCP requires that all project sites meet ARARs (or that an ARAR waiver be obtained).

Balancing Factors: These factors (long-term effectiveness, reduction, short-term effectiveness, implementability, and cost) are criteria that form the basis for comparison among alternatives that meet the threshold criteria. CERCLA requires that alternatives be developed for treating threats at the project site through treatment of TMV. For MEC, this requires removal and disposal of MEC.

In addition, remedies are required to be permanent to the maximum extent practicable and to be cost-effective. The five balancing factors described below are weighed against each other to determine which remedies meet these criteria. The NCP explains that in general, preferential weight is given to alternatives that offer advantages in terms of the reduction of TMV through treatment, and that achieve long-term effectiveness and permanence. However, the NCP also recognizes that some contamination problems will not be suitable for treatment and permanent remedies. The balancing process takes that preference into account, and weighs the proportionality of costs to effectiveness to select one or more remedies that are cost effective. The final risk management decision made for the site is one that determines which cost-effective remedy offers the best balance of all factors to achieve permanence to the maximum extent practical.

- Long-term effectiveness and permanence: The permanence criterion evaluates the degree to which an alternative permanently reduces or eliminates the potential for MEC or MC exposure hazard. This criterion also evaluates the magnitude of residual hazard/risk with the alternative in place, and the effectiveness of controls to manage the residual risk.
- Treatment of TMV: This criterion addresses the statutory preference for selecting remedies that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances. Non-removal alternatives have negligible impact in reducing sources or associated exposure hazards. Short-term effectiveness: The short-term effectiveness criterion addresses the potential consequences and risks of an alternative during the implementation phase. Alternatives were evaluated for their effects on human health and the environment prior to the remedy being completed. Short-term risks address adverse impacts to the workers and community during the construction and implementation phases of the remedy, as well as, the time it takes to complete the remedy.
- Implementability: The technical and administrative implementability criterion evaluates the difficulty of implementing a specific cleanup action alternative. The evaluation includes consideration of whether the alternative is technically possible; availability of necessary on-site and off-site facilities, services, and materials; administrative and regulatory requirements; and monitoring requirements.
- Cost: The cost criterion evaluates the financial cost to implement the alternative, including direct, indirect, and long-term operation and maintenance costs. A 30-year duration is used in this Feasibility Study for estimation purposes per EPA guidance but duration of some alternatives may be longer. Direct costs are those costs associated with the implementation of the alternative. Indirect costs are those costs associated with administration, oversight, and contingencies. Cost estimates presented are order-of-magnitude level estimates. Based on a variety of information, including productivity estimates (based on site conditions), cost estimating guides, and prior experience. The actual costs will depend on true labor rates, actual weather conditions, final project scope, and other variable factors. A present value analysis is used to evaluate costs (capital and operations and maintenance [O&M]) which occur over different time periods. The total present value (TPV) is the amount needed to be set aside at the initial point in time (base year) to assure that funds will be available in the future as they are needed. The discount rate of 7 percent per the EPA guidance, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (USEPA, 2000) was used to estimate TPV.

5.1.3 Two additional criteria, state acceptance and community acceptance of the remedy, are modifying factors and can play a role in weighing the balance between remedies that are cost effective and that meet other criteria. The technical project planning process and other public involvement activities help provide an understanding of these factors even though the Proposed Plan has not yet been issued. The community and state acceptance criteria are based on the degree of assumed acceptance from the local public and from state agencies regarding the implementation of alternatives. These criteria cannot be fully evaluated and assessed until comments on the FS and the Proposed Plan are received.

5.1.4 Each of the alternatives are analyzed individually against each criterion and then compared against one another to determine their respective strengths and weaknesses and to identify the key trade-offs. The alternative identified as the most practicable solution in reducing the MEC exposure hazard is selected with respect to each evaluation criteria. Based on the characteristics of these MRSs (receptors, land use, depth of intrusive activities) these eight MRSs can be grouped into two groups with identical receptors and land use. For each of the individual analysis of alternatives presented below, the sections are divided by the two groups of MRSs: military land use and private ownership. The military land use MRSs are Proposed MRS-01 and Proposed MRS-02 which are owned by Army National Guard and used for military training purposes at the Camp Butner Training Center. The Camp Butner Training Center proposed MRSs are restricted access and land use is not anticipated to change. Proposed MRS-03 through Proposed MRS-08 are privately owned MRSs with unrestricted access, identical land uses (residential, commercial/industrial, agriculture, undeveloped woodlands and recreational land use) and identical intrusive activities (farming, residential activities, utility construction, commercial construction).

5.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES – EVALUATED FOR MILITARY LAND USE Proposed MRS-01 AND Proposed MRS-02

5.2.1 Alternative 1: No Action

5.2.1.1 Description

5.2.1.1.1 The No Action alternative assumes that site conditions will remain the same. Source materials will not be removed, and access restrictions will not be implemented. This alternative is presented for comparative purposes to the other alternatives proposed, and assists in the assessment.

Threshold Factors

5.2.1.1.2 Alternative 1 provides no reduction in risk of MEC exposure and provides no protectiveness for human health (National Guard Trainees and site visitors) and the environment. Existing exposure pathways to the National Guard Trainees would be unchanged. The RAOs would not be met for the proposed MRSs. There are no ARARs associated with this alternative.

Balancing Factors

5.2.1.1.3 The No Action alternative includes no controls for exposure to MEC and no long-term management measures. All current and potential future risks would continue under this alternative.

The No Action alternative provides no reduction in TMV through treatment of MEC. There would be no additional risks posed to workers or the environment as a result of this alternative being implemented. There are no implementability concerns posed by this remedy and no cost incurred, since no action would be taken. Additionally, the present worth cost and capital cost of the No Action alternative are estimated to be $0, since there would be no action.

Summary – Alternative 1

5.2.1.1.4 There is no cost associated with Alternative 1, the No Action alternative, and this alternative does not reduce the potential exposure hazards. Alternative 1 does not provide overall protection to human health, as it does not implement a remedy to reduce potential future MEC exposure. In addition, there is no reduction in TMV through treatment. No Action does not meet the RAO. No costs are associated with this alternative.

5.2.2 Alternative 2: Land Use Controls

5.2.2.1 Description

5.2.2.1.1 Educational pamphlets and signage are the selected LUCs to limit exposure to MEC. Education and signage would warn authorized personnel of MEC contaminated areas. An educational pamphlet would inform the National Guard Trainees and other site visitors of potential MEC hazards and safety precautions to be taken to avoid contact with MEC. Warning signs would also limit exposure to MEC by attempting to limit National Guard Trainee intrusive activities to surface use only. Costs would include a LUC Implementation Plan that complies with the ARNG Master Plan, initial installation of signs and an educational pamphlet, and annual maintenance to replace and repair damaged fencing and signs and distribute educational pamphlets. LUCs would be applied to all MRSs.

5.2.2.1.2 Five-year reviews, as required by the NCP, would be conducted.

5.2.2.2 Assessment

Threshold Factors

5.2.2.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 2 by potentially limiting exposure through educational pamphlets and warning signs. Alternative 2 would potentially reduce the MEC hazard, but it would not completely eliminate risk because there would be no way to physically prevent exposure of receptors to MEC. MEC would remain on site throughout the Camp Butner Training Center, and National Guard Trainees could either ignore warnings, or not receive warnings, and potentially be exposed to MEC hazards. The MEC HA hazard level for the MEC-Contaminated AOI would not be reduced from the baseline (Table 2-2) hazard level for the applicable MRS after implementation of this alternative. There are no ARARs associated with this alternative.

Balancing Factors

5.2.2.2.2 Alternative 2 would potentially meet the long-term effectiveness and permanence criteria through education of potential receptors of the explosive hazards of MEC in the proposed MRSs. However, there would be no reduction of TMV through removal of source material, resulting in reduced long-term effectiveness. There would be some minimal risks posed to the field crew

installing signage. Implementability would be technically and administratively feasible and there would be no risk to the National Guard Trainees or site visitors resulting from implementation of this alternative. Installation/distribution and maintenance of LUCs would be in compliance to ARNG Master Plan.. This alternative is potentially more effective in the short-term when the LUCs are initially implemented. There is potential for reduced effectiveness over time due to inconsistencies and fluctuations in staff implementing and managing LUCs, and potential for damaged or stolen warning signs between review periods. Additionally, TMV would not be reduced. The overall long-term effectiveness of this alternative is potentially low due to the limited ability to prevent receptors from exposure to MEC hazards.

5.2.2.2.3 The total capital cost for this alternative is $131,339 for each proposed MRS. The TPV (30-year present worth) cost of this alternative is estimated to be $221,900. The total cost includes an initial cost of $131,339, an estimated cost of $48,224 for sign maintenance, and $201,560 for six Five-Year Review reports ($33,593 each) prepared over a period of 29 years. Details for the cost calculations are presented in Appendix A. The length of implementation of LUCs is unknown and for cost estimation purposes the estimate is limited to 30 years per USEPA guidance.

Summary – Alternative 2

5.2.2.2.4 The RAO would only be partially achieved through implementation of Alternative 2, in that it would potentially reduce exposure through interaction of human receptors with surface and subsurface MEC within the MEC-Contaminated AOI by educating and warning potential receptors of the MEC hazards. However, a negligible hazard determination and achievement of response complete could not be supported. This alternative would provide overall protection of human health and the environment and satisfy the balancing factor of permanence; but, no reduction of TMV through treatment, and potentially not long-term effectiveness. Alternative 2 could be readily implemented from a technical and administrative perspective, and there would be minimal risks posed to the field crew through the implementation of this alternative. Five-year reviews would be conducted following implementation of Alternative 2. The costs associated with implementing this alternative would be low.

5.2.3 Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

5.2.3.1 Description

5.2.3.1.1 Alternative 3 would provide surface clearance of MEC over the MRS utilizing analog detection methods and would be followed by the development of and distribution of educational pamphlets and the installation of signage similar to the details described for Alternative 2. For each proposed MRS, 100 percent coverage would be attempted. Surface removal of MEC would result in a reduction in the accessible MEC hazard. Educational pamphlets and signage would warn authorized personnel (National Guard Trainees) of MEC contaminated areas. Warning signs would attempt to modify receptor behavior by limiting National Guard Trainee intrusive activities to surface use only. Costs would also include initial installation of signs and an educational pamphlet, and annual maintenance to replace and repair damaged fencing and signs and distribute educational pamphlets.

5.2.3.1.2 Five-year reviews, as required by the NCP, would be conducted.

5.2.3.2 Assessment

Threshold Factors

5.2.3.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 3 through source removal of MEC. A MEC removal would be conducted within all of the proposed MRSs with the objective of identifying and removing MEC on the ground surface only. MEC was found on the surface in these MRSs; therefore, some source reduction would be achieved. The explosive hazards associated with MEC would be reduced through removal and subsequent destruction. Alternative 3 would be protective of human health in the short-term by removing MEC on the ground surface followed by LUCs which would be protective of human health in the long-term by effectively reducing the risk of exposure to the identified receptors by providing them with the necessary information to identify and mitigate the potential for direct contact with MEC. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved.

Balancing Factors

5.2.3.2.2 Alternative 3 will achieve the long-term effectiveness and permanence criteria through removal of MEC in the MRSs on the surface only. No subsurface MEC would be located and removed; therefore, there would not be a significant reduction of TMV through removal of all source material. The mobility of any remaining MEC in the MRS would not be reduced since residual MEC present in the top 30 inches of soil may be susceptible to erosion or freeze/thaw cycling. Only the source material at the surface would be removed and MEC could remain in the subsurface.

5.2.3.2.3 Similar to the tasks undertaken in support of the RI field activities, there would be some additional risks posed to the field crews conducting removal. The removal would be performed by qualified UXO technicians; however, there is potential to cause an accidental detonation as part of the remedy. Risk to the National Guard Trainees and site visitors resulting from implementation of this alternative is considered minimal. Alternative 3 would be readily implemented from a technical and administrative perspective. This type of remedy is effective and is similar to the RI intrusive investigation activities.

5.2.3.2.4 The capital cost for this alternative varies for each proposed MRS based on the acreage of each proposed MRS. The capital costs range from a minimum of $15M for Proposed MRS-02 to a maximum of $17M for Proposed MRS-01. Details for the cost calculations are presented in Appendix A. The TPV (30-year present worth) cost of this alternative ranges from 9.7M to 11M. The total cost includes an initial cost of $131,339 to develop educational materials and install signs, an estimated cost of $48,224 for sign maintenance, and $201,560 for six Five-Year Review reports ($33,593 each) prepared over a period of 29 years. Details for the cost calculations are presented in Appendix A. The total number of Five-Year Reviews is unknown and for cost estimation purposes the estimate is limited to 30 years per USEPA guidance.

Summary – Alternative 3

5.2.3.2.5 The RAO for Proposed MRS-01 and Proposed MRS-02 would be achieved through implementation of Alternative 3; this alternative would also provide overall protection of human health and the environment. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved. Alternative 3 would satisfy the balancing factors of long-term effectiveness, permanence, and reduction of TMV through treatment. Alternative 3 would be readily implemented from a technical perspective, but there would also be some risks posed to the field crew through the implementation of this alternative. The costs associated with implementing this alternative would be average.

5.2.4 Alternative 4: Surface Clearance and Subsurface Removal of MEC to the Depth of Instrument Detection Using DGM Detection Methods (UU/UE Method A)

5.2.4.1 Description

5.2.4.1.1 Alternative 4 would provide surface and subsurface clearance of all of the MRSs using DGM surveying, intrusive investigation, and removal of all anomalies potentially representing subsurface MEC to a depth of instrument detection (Table 3.2). Additionally, 100 percent coverage of the MRSs would be attempted but steep-sloped areas may prevent full coverage. Surface and subsurface removal of MEC would result in a significant reduction in the accessible MEC hazard. Surface and subsurface removal of MEC under this alternative would reduce hazards associated with MEC within the proposed MRS to levels that would allow UU/UE; therefore, Five-Year Reviews, would not be necessary.

5.2.4.2 Assessment

Threshold Factors

5.2.4.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 4 through source removal of MEC. A MEC removal would be conducted within all of the MRSs with the objective of identifying and removing MEC on the ground surface and in the subsurface to a depth of detection (Table 3.2). The MEC HA hazard level for the MEC-contaminated area would be reduced from the baseline (Table 2-2) hazard level, for the applicable MRSs, after implementation of this alternative. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved.

Balancing Factors

5.2.4.2.2 Alternative 4 will achieve the long-term effectiveness and permanence criteria through source removal of MEC in the MRSs, allowing UU/UE to be achieved. There would be a significant reduction of TMV through removal of source material.

5.2.4.2.3 Similar to the tasks undertaken in support of the RI field activities, there would be some additional risks posed to the field crews conducting removal. The removal would be performed by qualified UXO technicians; however, there is potential to cause an accidental detonation as part of the remedy. Risk to the National Guard Trainees and site visitors resulting from implementation of this alternative is considered minimal. Alternative 4 would be readily implemented from a technical perspective. Analog methods may be necessary in areas of

treacherous terrain where no other geophysical method is feasible. This type of remedy is effective and is similar to the RI intrusive investigation activities.

5.2.4.2.4 The capital cost for this alternative varies for each proposed MRS based on the acreage of each proposed MRS. The capital costs range from a minimum of $25M for Proposed MRS-02 to a maximum of $132M for Proposed MRS-04. The TPV (30-year present worth) cost of this alternative is not necessary because this alternative would allow UU/UE following completion, warranting NFA. Details for the cost calculations are presented in Appendix A.

Summary – Alternative 4

5.2.4.2.5 The RAO would be achieved through implementation of Alternative 4; this alternative would also provide overall protection of human health and the environment. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved. Alternative 4 would satisfy the balancing factors of long-term effectiveness, permanence, and reduction of TMV through treatment. Alternative 4 would be readily implemented from a technical perspective, but there would also be some risks posed to the field crew through the implementation of this alternative. The costs associated with implementing this alternative would be very high.

5.2.5 Alternative 5: Surface Clearance and Subsurface Removal of MEC to the Depth of Instrument Detection Using Advanced Classification Methods (UU/UE Method B)

5.2.5.1 Description

5.2.5.1.1 Alternative 5 would provide surface and subsurface clearance of all of the MRSs using DGM surveying, intrusive investigation, and removal of all targets of interest identified during AGC data evaluation potentially representing subsurface MEC to a depth of instrument detection. Costs would include vegetation removal, surface and subsurface clearance within MEC contaminated acreage, MEC disposal, and MPPEH inspection and disposal, along with site restoration. Additionally, 100 percent coverage of the MRSs would be attempted. Surface and subsurface removal of MEC would result in a significant reduction in the accessible MEC hazard. Surface and subsurface removal of MEC under this alternative would reduce hazards associated with MEC within the MRS to levels that would allow UU/UE; therefore, Five-Year Reviews, would not be necessary.

5.2.5.2 Assessment

Threshold Factors

5.2.5.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 5 through source removal of MEC. A MEC removal would be conducted within all MEC contaminated acreage along with the Buffer AOIs identified. The objective of Alternative 5 will be identifying and removing MEC on the ground surface and in the subsurface to a depth of detection. The MEC HA hazard level for the MEC-Contaminated AOI would be reduced from the baseline (Table 2-2) hazard level, for the applicable MRSs, after implementation of this alternative. The only ARAR identified for this alternative would be

Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved.

Balancing Factors

5.2.5.2.2 Alternative 5 would achieve the long-term effectiveness and permanence criteria through source removal of MEC in the MRSs, allowing UU/UE to be achieved. There would be a significant reduction of TMV through removal of source material.

5.2.5.2.3 Similar to the tasks undertaken in support of the RI field activities, there would be some additional risks posed to the field crews conducting removal or installing signage. The removal would be performed by qualified UXO technicians; however, there is potential to cause an accidental detonation as part of the remedy. Risk to the National Guard Trainees and site visitors resulting from implementation of this alternative is considered minimal. Alternative 5 would be readily implemented from a technical perspective. Analog methods may be necessary in areas of treacherous terrain where no other geophysical method is feasible. This type of remedy is effective and is similar to the RI intrusive investigation activities.

5.2.5.2.4 The capital cost for this alternative varies for each proposed MRS based on the acreage of each proposed MRS. The capital costs range from a minimum of $7M for Proposed MRS-02 to a maximum of $37M for Proposed MRS-04. The TPV (30-year present worth) cost of this alternative is not necessary because this alternative would allow UU/UE following completion, warranting NFA. Details for the cost calculations are presented in Appendix A.

Summary – Alternative 5

5.2.5.2.5 The RAO would be achieved through implementation of Alternative 5; this alternative would also provide overall protection of human health and the environment. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved. Alternative 5 would satisfy the balancing factors of long-term effectiveness, permanence, and reduction of TMV through treatment. Alternative 5 would be readily implemented from a technical perspective, but there would also be some risks posed to the field crew through the implementation of this alternative. The costs associated with implementing this alternative would be high, though lower than Alternative 4.

5.3 INDIVIDUAL ANALYSIS OF ALTERNATIVES – EVALUATED FOR Proposed MRS-03, Proposed MRS-04, Proposed MRS-05, Proposed MRS-06, Proposed MRS-07, AND Proposed MRS-08

5.3.1 Alternative 1: No Action

5.3.1.1 Description

5.3.1.1.1 The No Action alternative assumes that site conditions will remain the same. Source materials will not be removed, and access restrictions will not be implemented. This alternative is presented for comparative purposes to the other alternatives proposed, and assists in the assessment.

Threshold Factors

5.3.1.1.2 Alternative 1 provides no reduction in risk of MEC exposure and provides no protectiveness for human health (National Guard Trainees and site visitors) and the environment. Existing exposure pathways to the National Guard Trainees would be unchanged. The RAOs would not be met for the MRSs. There are no ARARs associated with this alternative.

Balancing Factors

5.3.1.1.3 The No Action alternative includes no controls for exposure to MEC and no long-term management measures. All current and potential future risks would continue under this alternative. The No Action alternative provides no reduction in TMV through treatment of MEC. There would be no additional risks posed to workers or the environment as a result of this alternative being implemented. There are no implementability concerns posed by this remedy and no cost incurred, since no action would be taken. Additionally, the present worth cost and capital cost of the No Action alternative are estimated to be $0, since there would be no action.

Summary – Alternative 1

5.3.1.1.4 There is no cost associated with Alternative 1, the No Action alternative, and this alternative does not reduce the potential exposure hazards. Alternative 1 does not provide overall protection to human health, as it does not implement a remedy to reduce potential future MC exposure. In addition, there is no reduction in TMV through treatment. No Action does not meet the RAOs for each proposed MRS. No costs are associated with this alternative.

5.3.2 Alternative 2: Land Use Controls

5.3.2.1 Description

5.3.2.1.1 Educational pamphlets and signage are the selected LUCs to limit exposure to MEC. Education and signage would warn authorized personnel of MEC contaminated areas. An educational pamphlet would inform the public of potential MEC hazards and safety precautions to be taken to avoid contact with MEC. Warning signs would also limit exposure to MEC by attempting to limit land use to surface use only. Costs would include initial installation of signs and an educational pamphlet, and annual maintenance to replace and repair damaged fencing and signs and distribute educational pamphlets. LUCs would be applied to all MRSs. The length of implementation of LUCs is unknown and for cost estimation purposes the estimate is limited to 30 years per USEPA guidance.

5.3.2.1.2 Five-year reviews, as required by the NCP, would be conducted.

5.3.2.2 Assessment

Threshold Factors

5.3.2.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 2 by potentially limiting exposure through educational pamphlets and warning signs. Alternative 2 would potentially reduce the MEC hazard, but it would not completely eliminate risk because there would be no way to physically prevent exposure of receptors to MEC. MEC

would remain on site throughout MRSs, and receptors could either ignore warnings, or not receive warnings, and potentially be exposed to MEC hazards. The MEC HA hazard level for the MEC-Contaminated AOI would not be reduced from the baseline (Table 2-2) hazard level for the applicable MRS after implementation of this alternative. There are no ARARs associated with this alternative.

Balancing Factors

5.3.2.2.2 Alternative 2 would potentially meet the long-term effectiveness and permanence criteria through limiting access to the MEC-Contaminated AOI of the MRSs. However, there would be no reduction of TMV through removal of source material, resulting in reduced long-term effectiveness. There would be some minimal risks posed to the field crew installing signage. There would be no risk to the public resulting from implementation of this alternative. Alternative 2 would be readily implemented from a technical perspective. This alternative is potentially more effective in the short-term when the LUCs are initially implemented. There is potential for reduced effectiveness over time due to inconsistencies and fluctuations in staff implementing and managing LUCs, and potential for damaged or stolen warning signs between review periods. Additionally, TMV would not be reduced. The overall long-term effectiveness of this alternative is potentially low due to the limited ability to prevent receptors from exposure to MEC hazards.
5.2.2.2.3 The total capital cost for this alternative is $131,339. The TPV (30-year present worth) cost of this alternative is estimated to be $221,900. The total cost includes an initial cost of $131,339, an estimated cost of $48,224 for sign maintenance, and $201,560 for six Five-Year Review reports ($33,593 each) prepared over a period of 29 years. Details for the cost calculations are presented in Appendix A. The length of implementation of LUCs is unknown and for cost estimation purposes the estimate is limited to 30 years per USEPA guidance.

Summary – Alternative 2

5.3.2.2.4 The RAOs would only be partially achieved through implementation of Alternative 2, in that it would potentially reduce exposure through interaction of human receptors with surface and subsurface MEC within the MEC-Contaminated AOI by educating and warning potential receptors of the MEC hazards. However, a negligible hazard determination and achievement of response complete could not be supported. This alternative would provide overall protection of human health and the environment and would satisfy the balancing factor of permanence; but, no reduction of TMV through treatment, and potentially not long-term effectiveness. Alternative 2 could be readily implemented from a technical perspective, and there would be minimal risks posed to the field crew through the implementation of this alternative. Five-year reviews would be conducted following implementation of Alternative 2. The costs associated with implementing this alternative would be low.

5.3.3 Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

5.3.3.1 Description

5.3.3.1.1 Alternative 3 would provide surface clearance of MEC over the MRS utilizing analog detection methods and would be followed by the development of and distribution of educational pamphlets and the installation of signage similar to the details described for Alternative 2. For each proposed MRS, 100 percent coverage would be attempted. Surface removal of MEC would result in a reduction in the accessible MEC hazard. Educational pamphlets and signage would

warn human receptors of MEC contaminated areas. Warning signs would attempt to modify receptor behavior by limiting intrusive activities to surface use only. Costs would also include initial installation of signs and an educational pamphlet, and annual maintenance to replace and repair damaged fencing and signs and distribute educational pamphlets.

5.3.3.1.2 Five-year reviews, as required by the NCP, would be conducted.

5.3.3.2 Assessment

Threshold Factors

5.3.3.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 3 through source removal of MEC. A MEC removal would be conducted within all of the MRSs with the objective of identifying and removing MEC on the ground surface. MEC was found on the ground surface in these MRSs; therefore, some source reduction would be achieved. The explosive hazards associated with MEC would be reduced through removal and subsequent destruction. Alternative 3 would be protective of human health in the short-term by removing MEC on the ground surface followed by LUCs which would be protective of human health in the long-term by effectively reducing the risk of exposure to the identified receptors by providing them with the necessary information to identify and mitigate the potential for direct contact with MEC. A completed pathway for exposure of human receptors to explosive hazards, resulting in unacceptable level of risk to human receptors will still exist. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved.

Balancing Factors

5.3.3.2.2 Alternative 3 will achieve the long-term effectiveness and permanence criteria through removal of MEC in the surface only. No subsurface MEC would be located and removed; therefore, there would not be a significant reduction of TMV through removal of all source material. The mobility of any remaining MEC in the MRS would not be reduced since residual MEC are present in the top 30 inches of soil may be susceptible to erosion or freeze/thaw cycling. These MRSs include residential, commercial/industrial, agriculture, undeveloped woodlands and recreational land use. The anticipated receptor intrusive activities in the MRSs may potentially contact MEC remaining in the subsurface. Only the source material at the surface would be removed and MEC could remain in the subsurface.

5.3.3.2.3 Similar to the tasks undertaken in support of the RI field activities, there would be some additional risks posed to the field crews conducting removal. The removal would be performed by qualified UXO technicians; however, there is potential to cause an accidental detonation as part of the remedy. Risk to the public resulting from implementation of this alternative is considered minimal. Alternative 3 would be readily implemented from a technical perspective. This type of remedy is effective and is similar to the RI intrusive investigation activities.

5.3.3.2.4 The capital cost for this alternative varies for each proposed MRS based on the acreage of each proposed MRS. The capital costs range from a minimum of 16M for Proposed MRS-03 to a maximum of $18.5M for Proposed MRS-04. The total cost includes an initial cost of $131,339

to develop educational materials and install signs, an estimated cost of $48,224 for sign maintenance, and $201,560 for six Five-Year Review reports ($33,593 each) prepared over a period of 29 years. Details for the cost calculations are presented in Appendix A.

Summary – Alternative 3

5.3.3.2.5 The RAOs would only partially be achieved through implementation of Alternative 3; this alternative alone would not provide overall protection of human health and the environment due to MEC remaining in the subsurface which may come into contact with human receptors. Overall protection would be achieved by including the LUCs of Alternative 2. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved. Alternative 3 would not satisfy the balancing factors of long-term effectiveness, permanence, and reduction of TMV through treatment, as MEC would remain in the subsurface where the human receptors are known to be conducting intrusive activities. Alternative 3 would be readily implemented from a technical perspective, but there would also be some risks posed to the field crew through the implementation of this alternative. The costs associated with implementing this alternative would be average.

5.3.4 Alternative 4: Surface Clearance and Subsurface Removal of MEC to the Depth of Instrument Detection Using DGM Detection Methods (UU/UE Method A)

5.3.4.1 Description

5.3.4.1.1 Alternative 4 would provide surface and subsurface clearance of all of the MRSs using DGM surveying, intrusive investigation, and removal of all anomalies potentially representing subsurface MEC to a depth of instrument detection (Table 3.2). Additionally, 100 percent coverage of the MRSs would be attempted but steep-sloped areas may prevent full coverage. Surface and subsurface removal of MEC would result in a significant reduction in the accessible MEC hazard. Surface and subsurface removal of MEC under this alternative would reduce hazards associated with MEC within the MRS to levels that would allow UU/UE; therefore, Five-Year Reviews, would not be necessary.

5.3.4.2 Assessment

Threshold Factors

5. 3.4.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 4 through source removal of MEC. A MEC removal would be conducted within all of the MRSs with the objective of identifying and removing MEC on the ground surface and in the subsurface to a depth of detection (Table 3.2). The MEC HA hazard level for the MEC-contaminated area would be reduced from the baseline (Table 2-2) hazard level, for the applicable MRSs, after implementation of this alternative. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved.

Balancing Factors

5. 3.4.2.2 Alternative 4 will achieve the long-term effectiveness and permanence criteria through source removal of MEC in the MRSs, allowing UU/UE to be achieved. There would be a significant reduction of TMV through removal of source material.

5. 3.4.2.3 Similar to the tasks undertaken in support of the RI field activities, there would be some additional risks posed to the field crews conducting removal. The removal would be performed by qualified UXO technicians; however, there is potential to cause an accidental detonation as part of the remedy. Risk to the public resulting from implementation of this alternative is considered minimal. Alternative 4 would be readily implemented from a technical perspective. Analog methods may be necessary in areas of treacherous terrain where no other geophysical method is feasible. This type of remedy is effective and is similar to the RI intrusive investigation activities.

5. 3.4.2.4 The capital cost for this alternative varies for each proposed MRS based on the acreage of each proposed MRS. The capital costs range from a minimum of $25M for Proposed MRS-02 to a maximum of $132M for Proposed MRS-04. The TPV (30-year present worth) cost of this alternative is not necessary because this alternative would allow UU/UE following completion, warranting NFA. Details for the cost calculations are presented in Appendix A.

Summary – Alternative 4

5. 3.4.2.5 The RAOs would be achieved through implementation of Alternative 4; this alternative would also provide overall protection of human health and the environment. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved. Alternative 4 would satisfy the balancing factors of long-term effectiveness, permanence, and reduction of TMV through treatment. Alternative 4 would be readily implemented from a technical perspective, but there would also be some risks posed to the field crew through the implementation of this alternative. The costs associated with implementing this alternative would be very high.

5.3.5 Alternative 5: Surface Clearance and Subsurface Removal of MEC to the Depth of Instrument Detection Using Advanced Classification Methods (UU/UE Method B)

5.3.5.1 Description

5.3.5.1.1 Alternative 5 would provide surface and subsurface clearance of all of the MRSs using DGM surveying, intrusive investigation, and removal of all targets of interest identified during AGC data evaluation potentially representing subsurface MEC to a depth of instrument detection. Costs would include vegetation removal, surface and subsurface clearance within MEC contaminated acreage, MEC disposal, and MPPEH inspection and disposal, along with site restoration. Additionally, 100 percent coverage of the MRSs would be attempted but steep-sloped areas may prevent full coverage. Surface and subsurface removal of MEC would result in a significant reduction in the accessible MEC hazard. Surface and subsurface removal of MEC under this alternative would reduce hazards associated with MEC within the MRS to levels that would allow UU/UE; therefore, Five-Year Reviews, would not be necessary.

5.3.5.2 Assessment

Threshold Factors

5.3.5.2.1 Overall protectiveness of human health and the environment would be achieved with Alternative 5 through source removal of MEC. A MEC removal would be conducted within all MEC contaminated acreage along with the Buffer AOIs identified. The objective of Alternative 5 will be identifying and removing MEC on the ground surface and in the subsurface to a depth of detection. The MEC HA hazard level for the MEC-contaminated area would be reduced from the baseline (Table 2-2) hazard level, for the applicable MRSs, after implementation of this alternative. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved.

Balancing Factors

5.3.5.2.2 Alternative 5 would achieve the long-term effectiveness and permanence criteria through source removal of MEC in the MRSs, allowing UU/UE to be achieved. There would be a significant reduction of TMV through removal of source material.

5.3.5.2.3 Similar to the tasks undertaken in support of the RI field activities, there would be some additional risks posed to the field crews conducting removal or installing signage. The removal would be performed by qualified UXO technicians; however, there is potential to cause an accidental detonation as part of the remedy. Risk to the public resulting from implementation of this alternative is considered minimal. Alternative 5 would be readily implemented from a technical perspective. Analog methods may be necessary in areas of treacherous terrain where no other geophysical method is feasible. This type of remedy is effective and is similar to the RI intrusive investigation activities.

5.3.5.2.4 The capital cost for this alternative varies for each proposed MRS based on the acreage of each proposed MRS. The capital costs range from a minimum of $7M for Proposed MRS-02 to a maximum of $37M for Proposed MRS-04. The TPV (30-year present worth) cost of this alternative is not necessary because this alternative would allow UU/UE following completion, warranting NFA. Details for the cost calculations are presented in Appendix A.

Summary – Alternative 5

5.3.5.2.5 The RAOs would be achieved through implementation of Alternative 5; this alternative would also provide overall protection of human health and the environment. The only ARAR identified for this alternative would be Subpart X 40 CFR 264.601, if consolidated shot activities are conducted and this ARAR will be achieved. Alternative 5 would satisfy the balancing factors of long-term effectiveness, permanence, and reduction of TMV through treatment. Alternative 5 would be readily implemented from a technical perspective, but there would also be some risks posed to the field crew through the implementation of this alternative. The costs associated with implementing this alternative would be high, though lower than Alternative 4.

6.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

6.1 INTRODUCTION

6.1.1 In the following analysis, the alternatives are evaluated in relation to one another for each of the evaluation criteria to identify the relative advantages and disadvantages of each alternative in terms of the threshold and balancing criteria. Table 6-1 summarizes the evaluation of the alternatives, and Table 6-2 summarizes the costs for each alternative. Details regarding the comparative analysis are provided in the following sections.

6.1.1 Overall Protection of Human Health and the Environment

6.1.1.1 The protectiveness criterion was evaluated in terms of possible future human interaction with MEC. Each alternative was also evaluated in terms of whether it would reduce the amount of MEC within the site, and the projected effects it would have on the existing environment. Because it does not remove potential MEC, Alternative 1 does not provide overall protection of human health.

6.1.1.2 Alternative 2 provides protection to human receptors, but would not completely eliminate risk since MEC would not be removed and there is potential for receptors to ignore or not receive educational pamphlets or warnings. Alternative 3 does not completely eliminate risk since MEC remains in the subsurface but overall protection is provided in combination with Alternative 2. There would still be risk to potential future receptors conducting intrusive activities. Alternatives 4 and 5 provide overall protection by removing subsurface MEC within the greatest area and to the greatest depths. Alternatives 3, 4, and 5 have potential for accidental detonation as part of the investigative or removal process. MEC HA hazard levels for Alternatives 4 and 5 would be reduced to 4 from the baseline of 1 and there would be no change from baseline associated with Alternative 1. In terms of overall protection of human health, it was determined that Alternatives 4 and 5 would provide the most protection.

6.1.2 Compliance with Applicable or Relevant and Appropriate Requirements

6.1.2.1 The ARAR Subpart X 40 CFR 264.601 would apply if consolidated shot activities are conducted during the alternatives. Waste material (such as deposition of explosives and metals in soil) resulting from disposal activities would be characterized by soil sampling in accordance with requirements. This ARAR would not apply to Alternatives 1 and 2 since no removal activities, and thus no consolidated shot activities, would be conducted. All applicable alternatives would comply with this ARAR and this criterion will be achieved.

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Table 6-1
Summary of Detailed Analysis of Alternatives

Alternative	Description	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, and Volume through Treatment	Short-Term Effectiveness	Implementability	Total Present Value Cost [a]
1	No Action	Not protectiveand does not meet the RAO. No source reduction. No reduction of future risk. No protection to human receptors.	Not applicable as there is no action.	Not effective, no reduction in MEC hazard.	No reduction of source area TMV through treatment.	Not effective, no reduction in MEC hazard.	Not applicable as there is no action.	$0
2	LUCs	Achieves RAO, though No source reduction. Reduction of future risks through education pamphlets and warning signs.	No ARARs identified.	The overall long-term effectiveness of this alternative is potentially low due to the limited ability to prevent receptors from exposure to MEC hazards.	No reduction of source area TMV through treatment.	Implementation of LUCs effective in short term. Possible short-term impacts associated with sign installation.	Readily implementable. Short duration of field effort.	$221,900 30 years of sign maintenance costs and Five-Year Review costs
3	Surface Clearance of MEC with Analog Detection Methods, and LUCs	Achieves RAO, though only partial source reduction in MEC. Reduction of future risks through education pamphlets and warning signs.	Achieves Subpart X 40 CFR 264.601, if consolidated shot activities are conducted.	The overall long-term effectiveness of this alternative is potentially low due to the limited ability to prevent receptors from exposure to MEC hazards and the participation of landowners required to accomplish LUCs.	Partial reduction of source area TMV through treatment.	Possible short-term impacts. Potential for UXO workers to be exposed during the removal. Risk to public resulting from implementation considered minimal.	Readily implementable. Field activities require specially trained technicians qualified to perform the work.	Capital costs from minimum of $15M to a maximum of $18.5M and LUCs: $221,900 30 years of sign maintenance costs and Five-Year Review costs
4	Surface Clearance and Subsurface Removal of MEC to a Depth of Detection Using DGM Detection Methods (UU/UE Method A)	Achieves RAO, Complete source area reduction to depth of detection. MEC would be removed.	Achieves Subpart X 40 CFR 264.601, if consolidated shot activities are conducted.	Would provide complete long-term effectiveness due to removal of source.	Would provide complete reduction of source area TMV through treatment.	Possible short-term impacts. Potential for UXO workers to be exposed during the removal. Risk to public resulting from implementation considered minimal.	Readily implementable under most conditions. Steep-sloped areas may prevent implementation. DGM requires qualified technicians and specialized equipment.	Capital costs only (minimum of $25M for Proposed MRS-02 to a maximum of $132M for Proposed MRS-04) No maintenance costs or Five-Year Reviews required.
5	Surface and Subsurface Removal of MEC to a Depth of Detection Using Advanced Classification Methods (UU/UE Method B)	Achieves RAO, Complete source area reduction to depth of detection. MEC would be removed.	Achieves Subpart X 40 CFR 264.601, if consolidated shot activities are conducted.	Would provide complete long-term effectiveness due to removal of source.	Would provide complete reduction of source area TMV through treatment.	Possible short-term impacts. Potential for UXO workers to be exposed during the removal. Risk to public resulting from implementation considered minimal.	Readily implementable under most conditions. Steep-sloped areas may prevent implementation. DGM requires qualified technicians and specialized equipment.	Capital costs only (minimum of $7M for Proposed MRS-02 to a maximum of $37M for Proposed MRS-04) No maintenance costs or Five-Year Reviews required.

Notes:
a) TPV cost is based on a 7 percent discount rate. Details of costs are provided in Appendix A.

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Table 6-2
Alternative Cost Comparison for Detailed Analysis

Alternative	Capital Cost	Annual O&M	Periodic Costs	TPV of Cost*	Lower End of TPV, (-30%)	Upper End of TPV, (+50%)
Proposed MRS-01, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$16,949,587	$39,142	$201,560	$17,190,289	$11,073,876	$25,555,099
4	$87,027,593	$-	$-	$87,027,593	$56,567,935	$130,541,389
5	$24,608,752	$-	$-	$24,608,752	$15,995,689	$36,913,128
Proposed MRS-02, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$14,905,935	$39,142	$201,560	$14,993,081	$9,745,503	$22,489,622
4	$25,525,516	$-	$-	$25,525,516	$16,591,586	$38,288,275
5	$7,196,845	$-	$-	$7,196,845	$4,677,949	$10,795,268
Proposed MRS-03, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$15,954,806	$39,142	$201,560	$16,041,952	$10,427,269	$24,062,928
4	$57,116,189	$-	$-	$57,116,189	$37,125,523	$85,674,284
5	$16,119,846	$-	$-	$16,119,846	$10,477,900	$24,179,769
Proposed MRS-04, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$18,471,234	$39,142	$201,560	$18,558,380	$12,062,947	$27,837,569
4	$132,773,591	$-	$-	$132,773,591	$86,302,834	$199,160,387
5	$37,456,528	$-	$-	$37,456,528	$24,346,743	$56,184,793
Proposed MRS-05, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$17,695,858	$39,142	$201,560	$17,783,00	$11,558,952	$26,674,505
4	$109,387,091	$-	$-	$109,387,091	$71,101,609	$164,080,636
5	$30,865,435	$-	$-	$30,865,435	$20,062,533	$46,298,152
Proposed MRS-06, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$16,994,920	$39,142	$201,560	$17,082,066	$11,103,343	$25,623,099
4	$88,287,386	$-	$-	$88,287,386	$57,386,801	$132,431,080
5	$24,888,992	$-	$-	$24,888,992	$16,177,845	$37,333,489
Proposed MRS-07, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$16,866,570	$39,142	$201,560	$16,953,715	$11,019,915	$25,430,573
4	$84,414,306	$-	$-	$84,414,306	$54,869,299	$126,621,459
5	$23,845,027	$-	$-	$23,845,027	$15,499,268	$35,767,541
Proposed MRS-08, Alternative Costs						
1	$-	$-	$-	$-	$-	$-
2	$131,339	$48,224	$201,560	$221,900	$144,235	$332,850
3	$16,460,922	$39,142	$201,560	$16,548,068	$10,756,244	$24,822,102
4	$72,192,851	$-	$-	$72,192,851	$46,925,353	$108,289,277
5	$20,368,555	$-	$-	$20,368,555	$13,239,560	$30,552,832

*Includes a 7 percent discount factor.

6.1.3 Long-Term Effectiveness and Permanence

6.1.3.1 The long-term effectiveness and permanence criterion evaluates the degree to which an alternative permanently reduces or eliminates the potential for a MEC exposure hazard. Alternatives 4 and 5 both provide a complete reduction of source area TMV, and would warrant NFA. Alternative 2 is likely effective in the short-term; however, long-term effectiveness is considered to be low. Alternative 3 provides some effectiveness by removing surface MEC; however, long-term effectiveness is considered to be low and is dependent on landowner participation for installation of signage and compliance with public education. Alternatives 4 and 5 were determined to provide the best long-term effectiveness and permanence because they would significantly reduce the risk due to possible MEC.

6.1.4 Reduction of Toxicity, Mobility, and Volume through Treatment

6.1.4.1 Alternatives 4 and 5 provide the greatest reduction of TMV through treatment as a result of subsurface removal of the source to the maximum anticipated depth of MEC contamination. Alternative 3 provides a partial reduction of TMV through treatment as a result of surface only removal of MEC. Alternatives 1 and 2 offer no reduction in TMV through treatment of contaminants.

6.1.5 Short-Term Effectiveness

6.1.5.1 Alternative 1 presents no short-term impacts or adverse impacts on workers and the community. Alternative 2 is considered to be effective in the short-term, and present minimal risk to workers implementing the alternative. Alternative 3 has some short-term effectiveness and also presents risks to workers implementing the removal. Alternatives 4 and 5 are determined to have the least short-term effectiveness because of the risk to workers conducting removal. Due to the increased likelihood of MEC detonation during implementation of Alternatives 4 and 5, trained technicians must perform the work.

6.1.6 Implementability

6.1.6.2 There are no implementability limitations associated with Alternatives 1 and 2. Alternatives 3, 4 and 5 are all technically and administratively feasible but require specialized personnel and equipment to implement, and require the development of detailed work plans.

6.1.7 Cost

6.1.7.1 The cost criterion evaluates the financial cost to implement the alternative, including direct, indirect, and long-term operation and maintenance costs. Cost estimates are limited to a 30-year duration per USEPA guidance but implementation of some alternatives, such as LUCs, may go beyond the analysis period. These costs were adapted from costs associated with similar activities conducted at the site and cost estimates prepared for others. Alternative 1 requires no action; therefore, no costs would be incurred. Alternative 2 would have lower costs compared to Alternatives 3, 4, and 5, which would be the most costly to implement, with Alternative 4 having the highest relative costs.

6.1.7.2 Overall, costs are MRS-specific and range from $0 (Alternative 1) to over $133 million (Alternative 4). Alternative 4 has the highest cost because it includes surface clearance and subsurface clearance of MEC over all of the MRSs to a depth of instrument detection utilizing DGM/dynamic advanced sensor methods and attempts to provide 100 percent coverage, in order to obtain UU/UE. Alternative 5 has the second highest costs compared among all alternatives as this alternative also obtains UU/UE and incorporates removal of MEC to a depth of detection using AGC methods (resulting in significantly fewer MEC excavations expected) and attempts 100 percent coverage. Appendix A summarizes costs for all alternatives.

6.1.8 State and Community Acceptance

6.1.8.1 State acceptance cannot be fully evaluated and assessed until comments on the FS and the Proposed Plan are received.

6.2 SUMMARY OF COMPARATIVE ANALYSIS

6.2.1.1 This Feasibility Study evaluates various alternatives but does not select an alternative for future response actions. The selection of an alternative must be made by the USACE following the review of this FS. The preferred alternative will be identified in a subsequent document, the Proposed Plan, which will be prepared and submitted separately for public comment. A Decision Document will then be issued to present the selected remedy.

6.2.1.2 The alternatives were evaluated in this FS in terms of the NCP criteria, including threshold factors, balancing factors, and modifying factors. The results of the comparative analysis for each proposed MRS are presented below.

6.2.1.3 **Proposed MRS-01 - Military Training MEC Contaminated Area**. Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and meeting the RAO. Alternative 2 would reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower in cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. However, Proposed MRS-01 is exclusively military land use as it is completely within the Army National Guard / North Carolina National Guard Camp Butner Training Center. As such, access to the MRS is restricted and controlled and receptors consist of National Guard trainees and potential tresspassers. Alternatives 4 and 5 would meet the RAO by remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors to acceptable levels. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the proposed MRS, as the level of effort attempts to reach 100 percent coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2. Additionally, the MRS will continue to be operated by the Army National Guard as an active small arms weapons training center. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

6.2.1.4 **Proposed MRS-02 - Military Training Buffer Area**. Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and meeting the RAO. Alternative 2 would reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower in cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. However, Proposed MRS-02 is exclusively military land use as it is completely within the Army National Guard / North Carolina National Guard Camp Butner Training Center. As such, access to the proposed MRS is restricted and controlled and receptors consist of National Guard trainees only. Alternatives 4 and 5 would remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the proposed MRS, as the level of effort attempts to reach 100 percent coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2. Additionally, the MRS will continue to be operated by the Army National Guard as an active small arms weapons training center and there was no MEC confirmed during previous investigations, small amounts of MD only were located in the MRS. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

6.2.1.5 **Proposed MRS-03 - Buffer Area.** Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and meeting the RAO. Alternative 2 would potentially reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. Alternatives 4 and 5 would remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the proposed MRS, as the level of effort attempts to reach 100% coverage. For steep-sloped areas where the terrain is too treacherous for DGM equipment, analog methods will be required for 100% coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2. MEC presence was not confirmed during previous investigations, small amounts of MD only were located in the proposed MRS. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

6.2.1.6 **Proposed MRS-04 - MEC-Contaminated AOI (Central)**. Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and meeting the RAO. Alternative 2 would reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower in cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors

from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. Alternatives 4 and 5 would remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the MRSs, as the level of effort attempts to reach 100% coverage. For steep-sloped areas where the terrain is too treacherous for DGM equipment, analog methods will be required for 100% coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2 and Alternative 3. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

6.2.1.7 **Proposed MRS-05 - MEC-Contaminated AOI (Northern)**. Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and meeting the RAO. Alternative 2 would reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower in cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. Alternatives 4 and 5 would remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the MRSs, as the level of effort attempts to reach 100% coverage. For steep-sloped areas where the terrain is too treacherous for DGM equipment, analog methods will be required for 100% coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2 and Alternative 3. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

6.2.1.8 **Proposed MRS-06 - MEC-Contaminated AOI (Eastern)**, Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and meeting the RAO. Alternative 2 would reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower in cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. Alternatives 4 and 5 would remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the MRSs, as the level of effort attempts to reach 100% coverage. For steep-sloped areas where the terrain is too treacherous for DGM equipment, analog methods will be required for 100% coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2 and Alternative 3. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

6.2.1.9 **Proposed MRS-07 - MEC-Contaminated AOI (Western).** Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and

meeting the RAO. Alternative 2 would reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower in cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. Alternatives 4 and 5 would remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the MRSs, as the level of effort attempts to reach 100% coverage. For steep-sloped areas where the terrain is too treacherous for DGM equipment, analog methods will be required for 100% coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2 and Alternative 3. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

6.2.1.10 **Proposed MRS-08 - MEC-Contaminated AOI (South)**. Alternatives 4 and 5 are considered the most effective alternatives for reducing potential risk within the proposed MRS and meeting the RAO. Alternative 2 would reduce exposure to MEC and meet the RAO, but the overall effectiveness is limited because there is no reduction in TMV through treatment, and there is still potential for receptors to access the MEC contaminated area. Alternative 3 would provide a partial reduction in TMV through treatment and disposal; with MEC remaining in the subsurface; and is lower in cost than Alternatives 4 and 5. Alternative 3, alone, would not be protective to receptors from contact with subsurface MEC requiring LUCs (Alternative 2) for overall protectiveness. Alternatives 4 and 5 would remove MEC contamination from the areas where MEC has the highest probability of being located, mitigating MEC hazards and reducing risk for potential receptors. Completion of Alternatives 4 and 5 would also achieve UU/UE (as defined), warranting NFA for the MRSs, as the level of effort attempts to reach 100% coverage. For steep-sloped areas where the terrain is too treacherous for DGM equipment, analog methods will be required for 100% coverage. However, the costs associated with Alternatives 4 and 5 are comparatively higher than Alternative 2 and Alternative 3. Overall protection of human health and the environment would be attained by all alternatives except Alternative 1 (No Action).

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7.0 REFERENCES

Federal Remediation Technologies Roundtable (FRTR), 2007. Remediation Technologies Screening Matrix and Reference Guide Version 4.0, Federal Remediation Technologies Roundtable. January.

HydroGeoLogic, Inc. (HGL), 2016. Final Remedial Investigation Report, for MRSs at Former Camp Butner, Granville County, North Carolina. April.

U.S. Army Corps of Engineers (USACE), 1993. Archives Search Report, Findings for the former Butner, North Carolina, Project Number 104NC000902. September.

USACE, 2006. Engineer Pamphlet 1110-1-18; Engineering and Design, Military Munitions Response Process, April 3.

USACE, 2015. Technical Guidance for Military Munitions Response Actions, Interim Guidance Document EM 200-1-15, October.

USACE, 2017. Final Pilot Study Advanced Geophysical Classification Spring Valley Formerly Used Defense Site Spring Valley, Washington, DC. USACE Baltimore, April.

U.S. Department of Defense (DoD), 2012. Defense Environmental Restoration Program, Department of Defense Manual, Number 4715.20, March 9, 2012.

U.S. Environmental Protection Agency (USEPA), 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (Interim final). Document No. EPA/540/G-89/004, Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-01, Office of Emergency and Remedial Response, Washington, D.C., October.

USEPA, 1992. "CERCLA/SUPERFUND Orientation Manual," EPA/542/R-92/005, U.S. Environmental Protection Agency - Office of Solid Waste and Emergency Response Technology Innovation Office, October.

USEPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study, Office of Solid Waste and Emergency Response, Washington, D.C., EPA540-R-00-002, July.

USEPA, 2008. Interim MEC Hazard Assessment Methodology. EPA: 505B08001. October.

USEPA, 2013. Regional Screening Levels (Formerly PRGs): Screening Levels for Chemical Contaminants, http://www.epa.gov/region9/superfund/prg/, December.

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FIGURES

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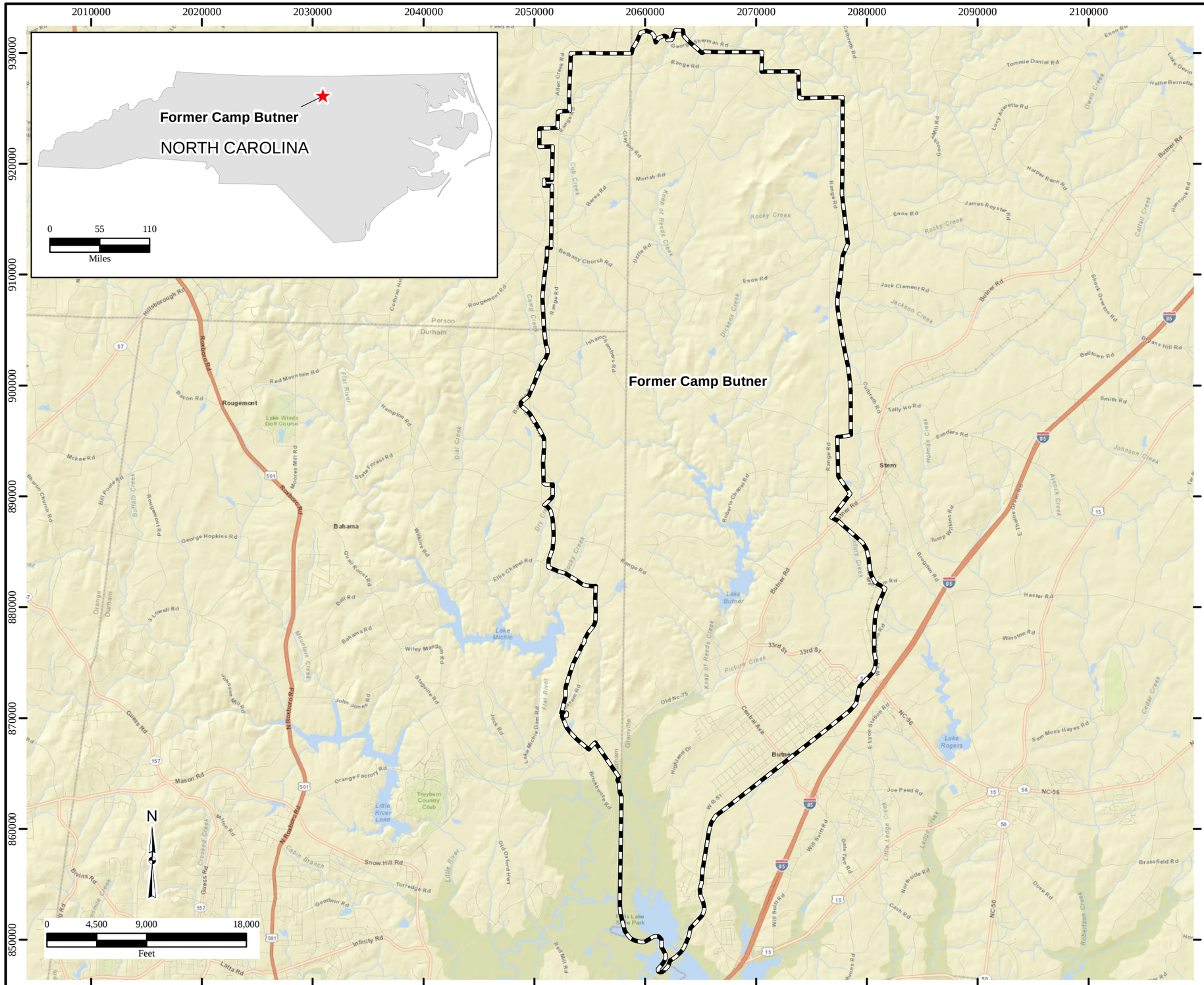
Figure 2.1
Site Location



Legend

Former Camp Butner

Notes:
FS=Feasibility Study
RI=Remedial Investigation

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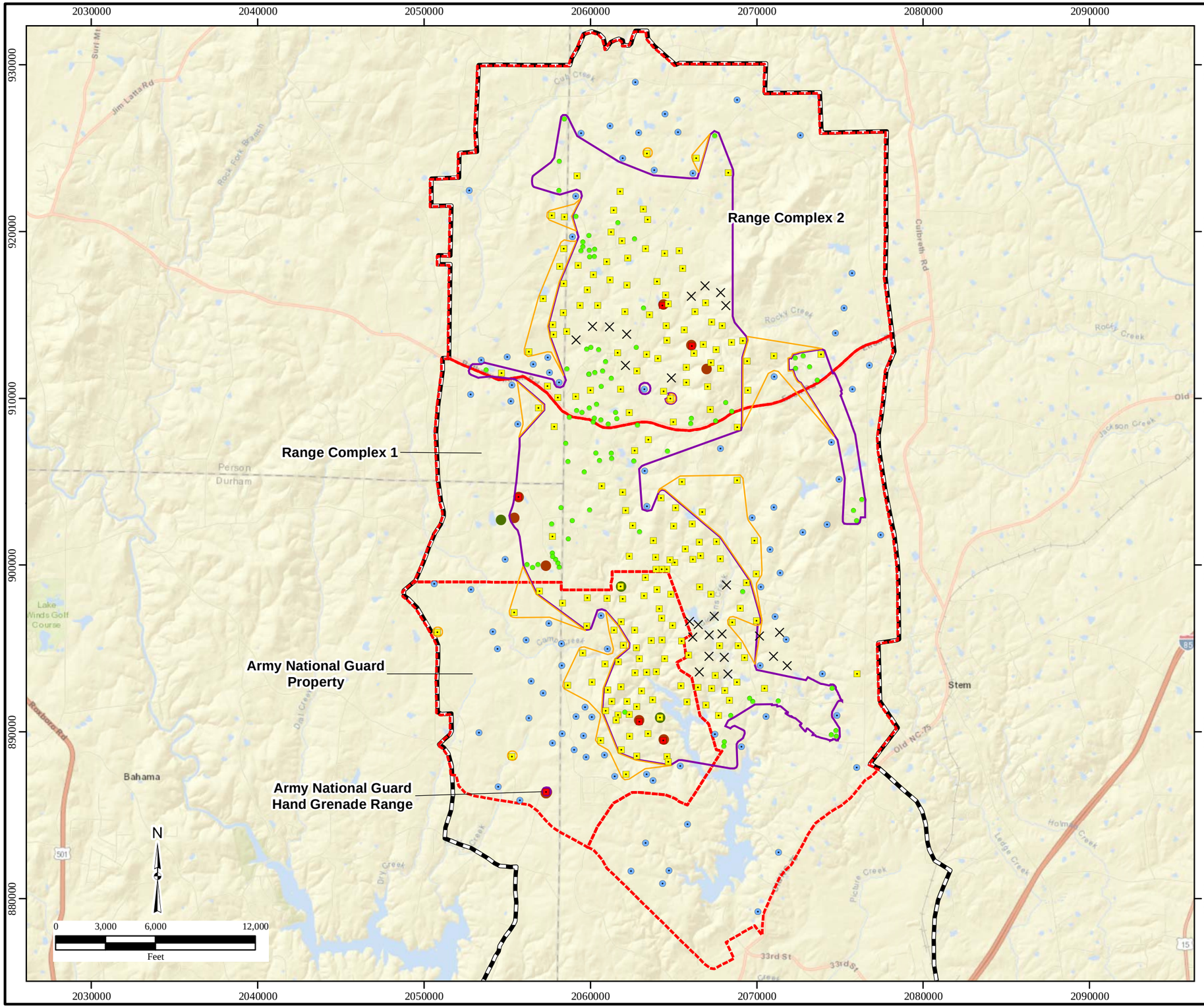
(1-01)Gen_Loc.mxd
2/4/2014 JP, QC: 02/21/2012 TH
Source: HGL, USACE
ESRI Online Street Map

Figure 2.2a
Remedial Investigation
MEC Delineation



Legend

- MEC
- Munition Debris
- Historical MEC Findings

Grid Intrusive Results

- MEC
- Munition Debris
- Cultural Debris
- Access Refused
- MEC Contamination To Be Investigated in FS
- To Be Investigated in FS
- MRS
- Former Camp Butner

Notes:
Grid locations displayed are the southwest corner points.
ARNG MRS MEC-Contaminated Area = 1429.19 acres
ARNG MRS 5-Year Review Area = 402.20 acres
ARNG MRS not MEC-Contaminated Area = 2993.07 acres
RC1 MRS MEC-Contaminated Area = 3900.99 acres
RC1 5-Year Review Area = 493.80 acres
RC1 MRS not MEC-Contaminated Area = 7968.30 acres
RC2 MRS MEC-Contaminated Area = 4100.45 acres
RC2 5-Year Review Area = 439.28 acres
RC2 MRS not MEC-Contaminated Area = 6989.60 acres

Remaining lands to be investigated in FS = 1390.98 acres

ARNG=Army National Guard Property
FS=feasibility study
MRS=Munition Response Site
MEC=Munitions and Explosives of Concern
RC=range complex

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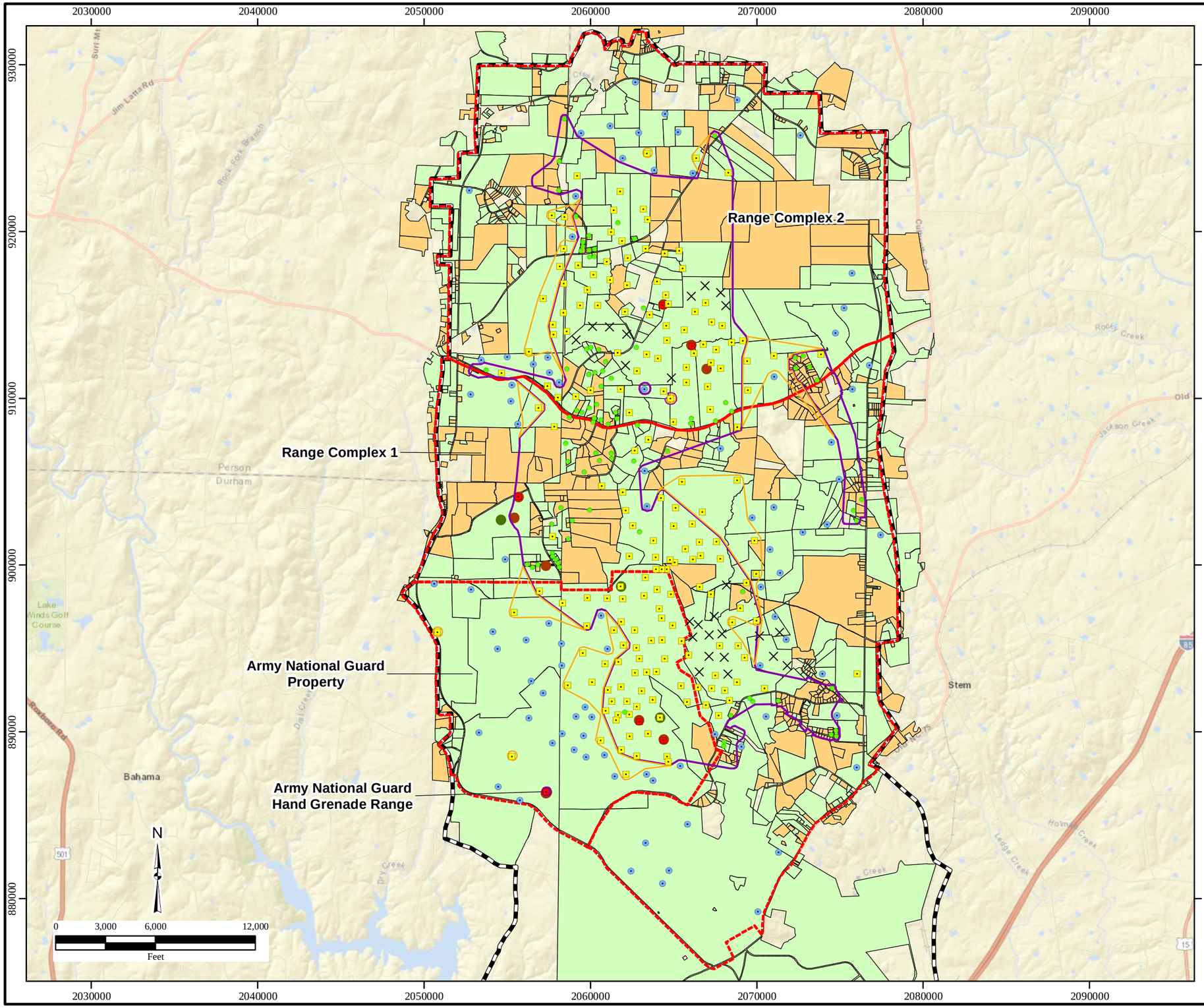
Source: HGL, USACE
ESRI Online Aerial Imagery

Figure 2.2b
Remedial Investigation
MEC Delineation with
Right-of-Entry Status



Legend

- MEC
- Munition Debris
- Historical MEC Findings

Grid Intrusive Results

- MEC
- Munition Debris
- Cultural Debris
- Access Refused
- MEC Contamination To Be Investigated in FS
- To Be Investigated in FS
- ROE Granted
- ROE Refused
- MRS
- Former Camp Butner

Notes:
Grid locations displayed are the southwest corner points.
ARNG MRS MEC-Contaminated Area = 1429.19 acres
ARNG MRS 5-Year Review Area = 402.20 acres
ARNG MRS not MEC-Contaminated Area = 2993.07 acres
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RC=range complex

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(2-02b)ROE_MEC_Delineation.mxd
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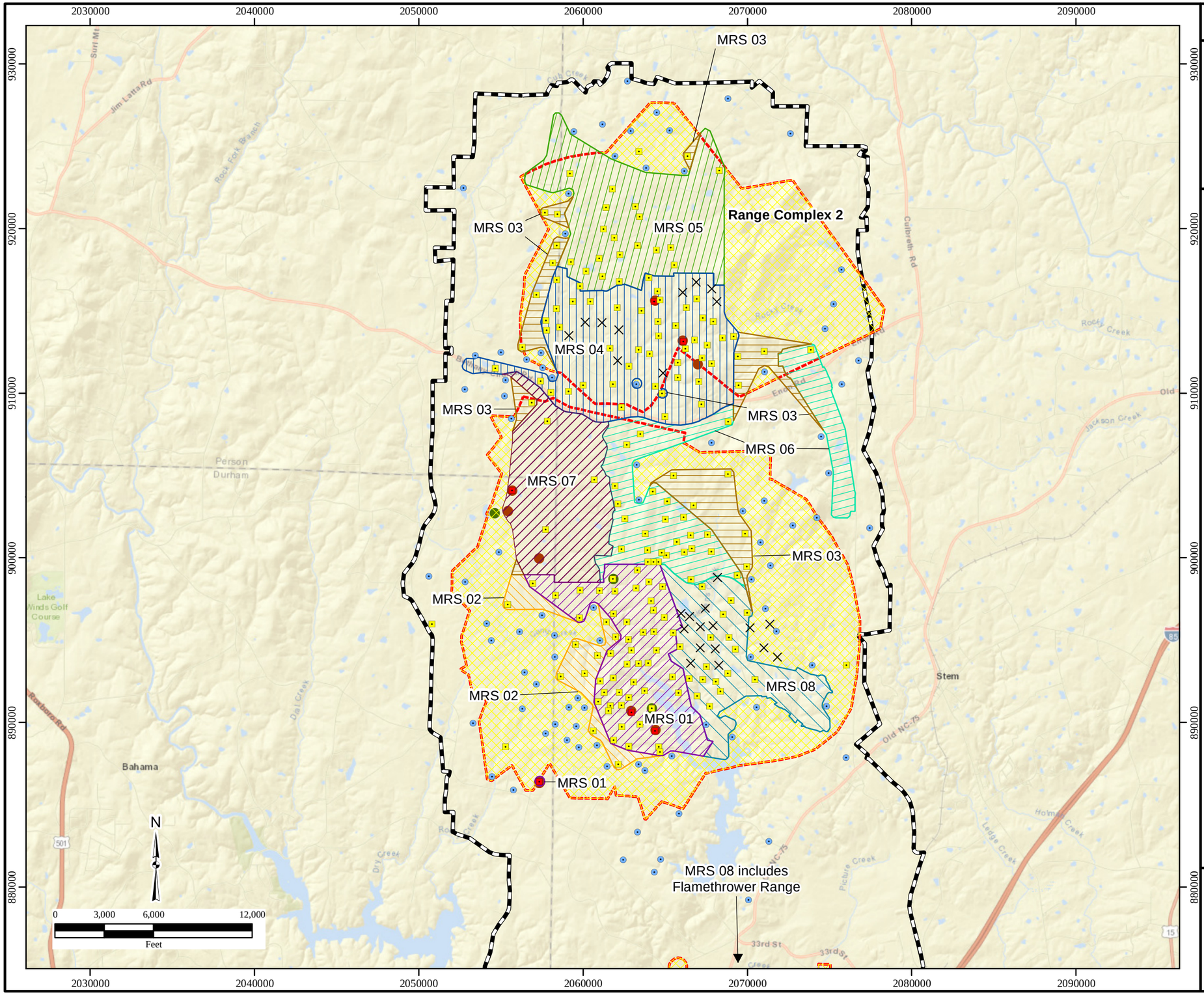
Source: HGL, USACE
ESRI Online Aerial Imagery

Figure 2.3
Feasibility Study Recommended MRS Boundaries



Legend

- MEC
- Munition Debris

Grid Intrusive Results

- MEC
- Munition Debris
- Cultural Debris
- Access Refused

FS Recommended MRS

- Proposed MRS 01
- Proposed MRS 02
- Proposed MRS 03
- Proposed MRS 04
- Proposed MRS 05
- Proposed MRS 06
- Proposed MRS 07
- Proposed MRS 08
- Proposed MRS 09
- MRS Boundary, 2014
- Former Camp Butner

Notes:
Grid locations displayed are the southwest corner points.
Areas are calculated using the projection NAD 1983 UTM Zone 17N.
MRS 01 = 1,429.41 acres
MRS 02 = 390.86 acres
MRS 03 = 923.54 acres
MRS 04 = 2,201.77 acres
MRS 05 = 1,806.34 acres
MRS 06 = 1,450.83 acres
MRS 07 = 1,384.52 acres
MRS 08 = 1,178.81 acres
MRS09 = 7,148.15 acres
ARNG=Army National Guard Property
FS=feasibility study
MRS=Munition Response Site
MEC=Munitions and Explosives of Concern
RC=range complex

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(2-03)FS_Recommended_MRS.mxd
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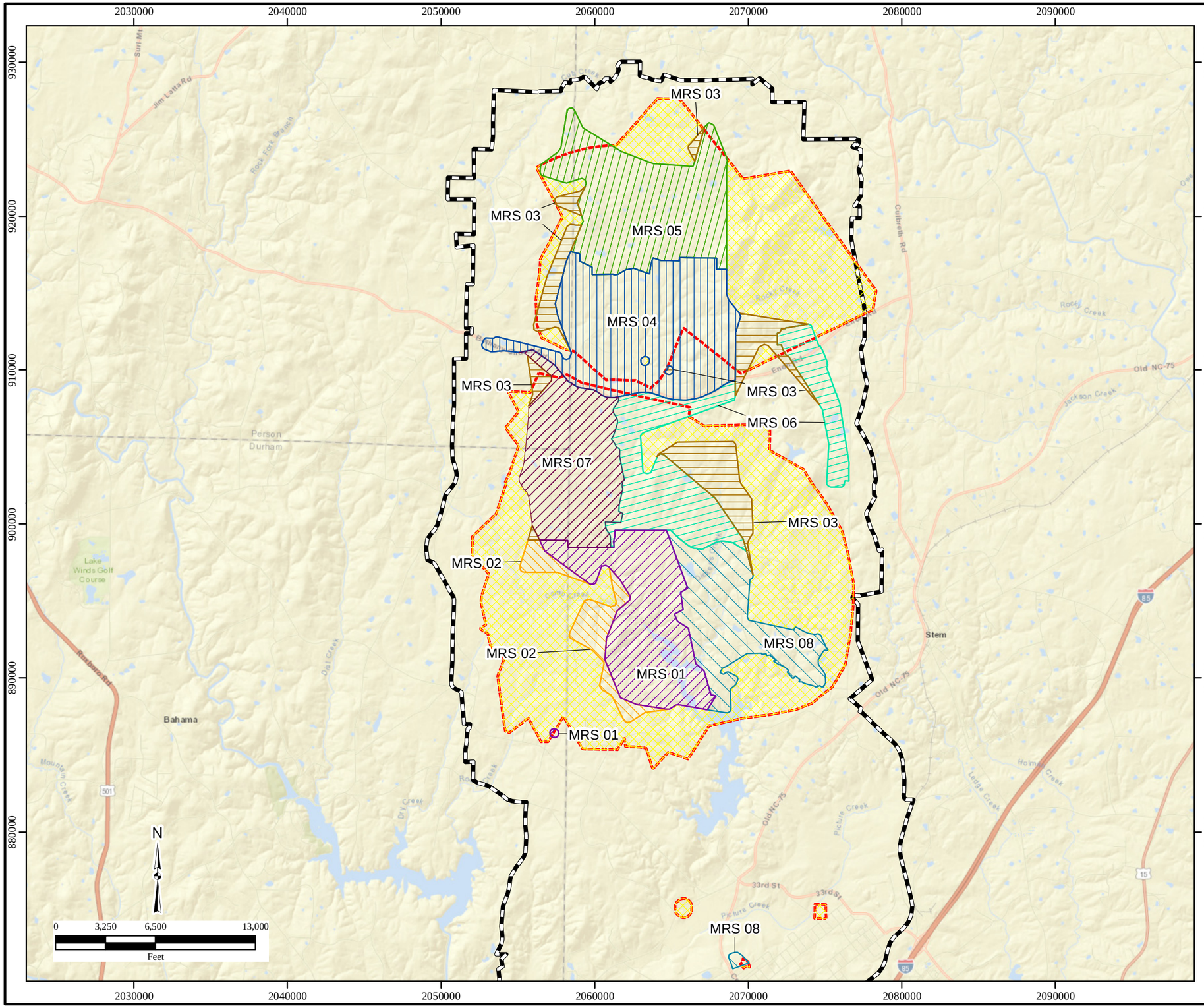
Source: HGL, USACE
ESRI Online Aerial Imagery

Figure 2.4
Feasibility Study
Recommended MRS Boundaries



Legend

FS Recommended MRS

- Proposed MRS 01
- Proposed MRS 02
- Proposed MRS 03
- Proposed MRS 04
- Proposed MRS 05
- Proposed MRS 06
- Proposed MRS 07
- Proposed MRS 08
- Proposed MRS 09

MRS Boundary, 2014

Former Camp Butner

Notes:
Areas are calculated using the projection NAD 1983 UTM Zone 17N.
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FS=feasibility study
MRS=Munition Response Site
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(2-04)FS_Recommended_MRS_clean.mxd
10/11/2017 CNL
Source: HGL, USACE
ESRI Online Aerial Imagery

FIGURE 3.1 RETAINED PROCESS OPTIONS AND TECHNOLOGIES

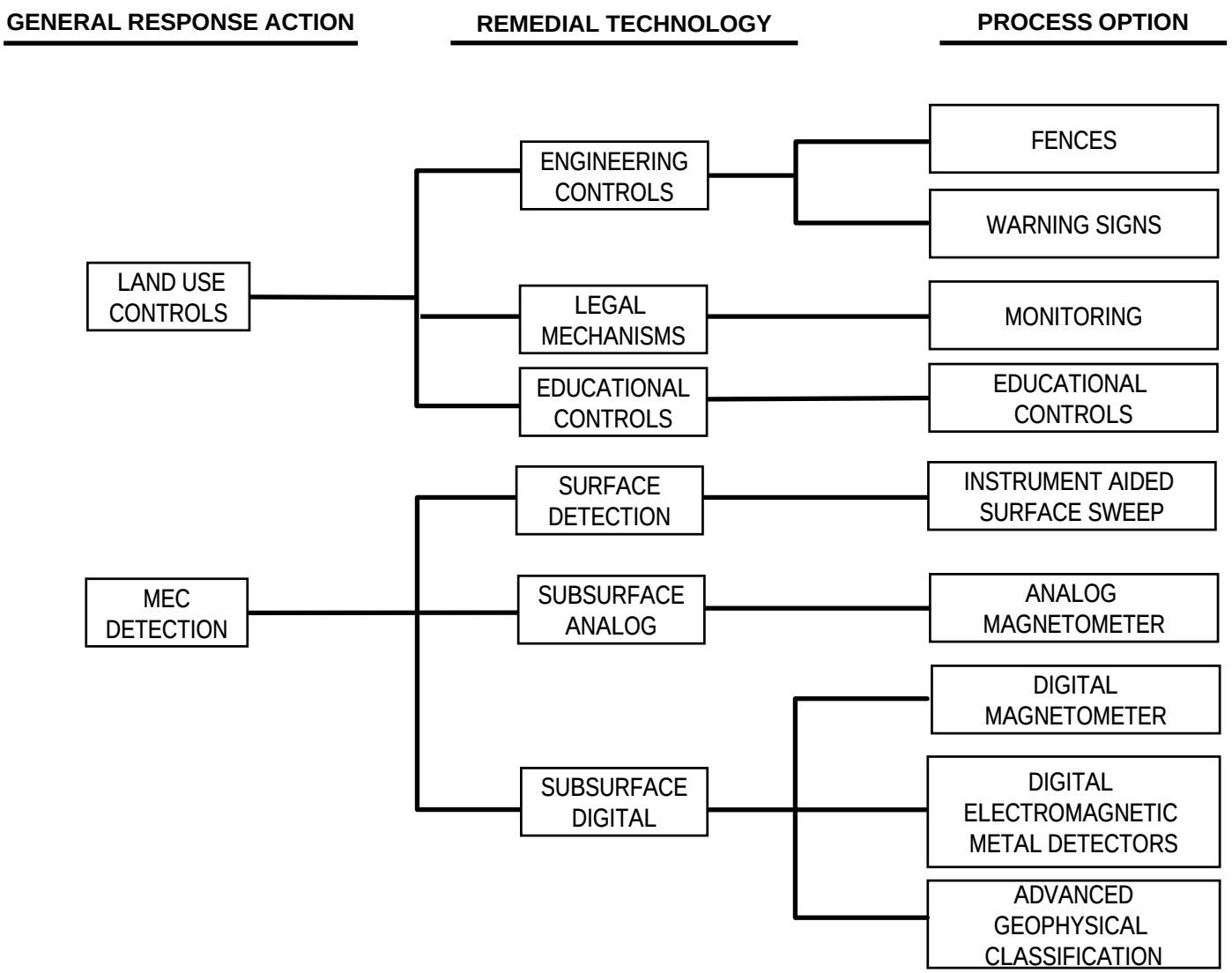
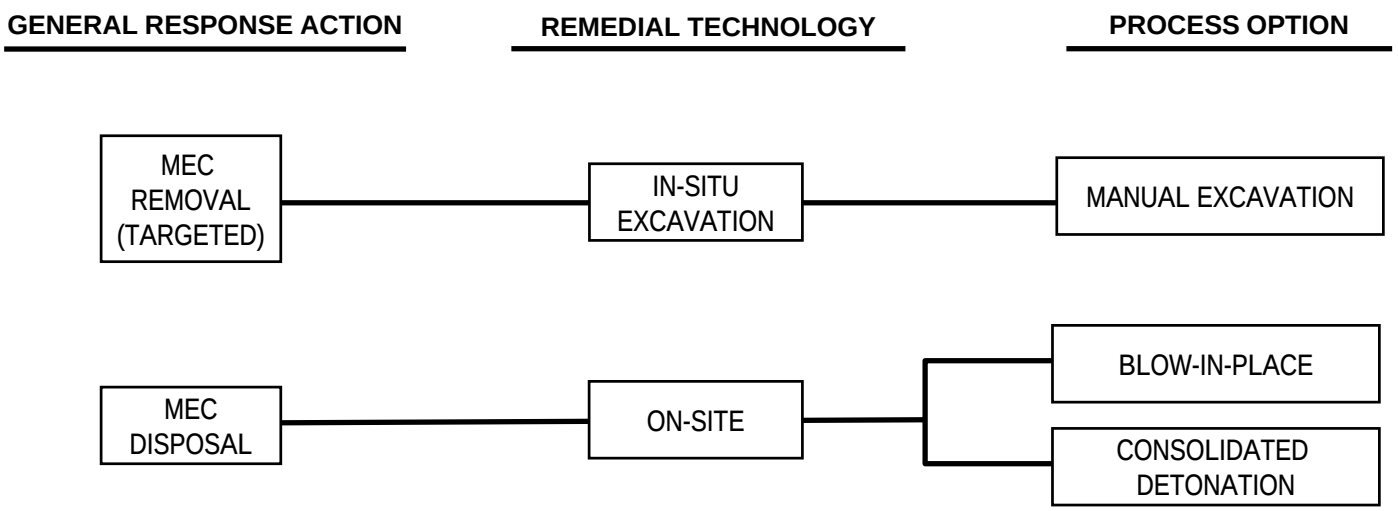


FIGURE 3.1 RETAINED PROCESS OPTIONS AND TECHNOLOGIES



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APPENDIX A

REMEDIAL ACTION ALTERNATIVE COST CALCULATIONS

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	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-01, 1429 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-01, 1429 acres	$ 16,949,587	$ 39,142	$ 201,560	$ 17,190,289	$ 17,036,733	$ 11,073,876	$ 25,555,099
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-01, 1429 acres	$ 87,027,593	$ -	$ -	$ 87,027,593	$ 87,027,593	$ 56,567,935	$ 130,541,389
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-01, 1429 acres	$ 24,608,752	$ -	$ -	$ 24,608,752	$ 24,608,752	$ 15,995,689	$ 36,913,128

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) [1]	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs [2]	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report [4]	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value [5]				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

[1] Includes development of Work Plan and supporting documents, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	106	hours	$150.94	$15,972.13
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	46	hours	$55.78	$2,555.72
Total Labor (Home Site) [(1)]	**590**	**hours**		**$69,164.93**
Labor Category (Field Site)				
UXO Tech I	20,214	hours	$34.96	$706,681.44
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	14,662	hours	$37.76	$553,637.12
UXO Tech II	13,667	hours	$42.29	$577,988.89
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	10,125	hours	$45.67	$462,408.75
UXO Tech III	6,782	hours	$50.69	$343,779.58
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	5,238	hours	$54.75	$286,780.50
Senior UXO Supervisor	303	hours	$63.11	$19,099.33
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	1,049	hours	$68.76	$72,129.24
UXO Safety Officer	259	hours	$59.78	$15,483.02
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	1,049	hours	$65.14	$68,331.86
UXO Quality Control Specialist	259	hours	$57.14	$14,799.26
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	1,049	hours	$62.25	$65,300.25
Total Labor (Field Site)	**204,560**	**hours**		**$8,595,289.96**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,611,906.44	$1,611,906.44
Travel Costs [(2)]	1	lump sum	$2,925,658.91	$2,925,658.91
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$6,919,165.35**
Subtotal				**$15,583,620.24**
G&A (excluding labor) @ 7.99%				$493,336.49
Subtotal (excluding fee)				**$16,076,956.73**
Fee (excluding labor & travel) @ 4.00%				$179,473.72
Fee (on labor) @ 8.00%				$693,156.39
Total Capital Costs				**$16,949,586.84**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$17,036,732.71**
Lower End of TPV Range at -35%				**$11,073,876.26**
Upper End of TPV Range at +50%				**$25,555,099.07**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	466	hours	$156.27	$72,821.82
Site Geophysicist	2,411	hours	$107.41	$258,965.51
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**3,629**	**hours**		**$426,774.45**
Labor Category (Field Site)				
UXO Tech I	104,646	hours	$34.96	$3,658,426.96
UXO Tech I (4% hazard)	12,920	hours	$36.36	$469,771.20
UXO Tech I (8% hazard)	376,192	hours	$37.76	$14,205,022.00
UXO Tech II	104,399	hours	$42.29	$4,415,021.87
UXO Tech II (4% hazard)	10,456	hours	$43.98	$459,854.88
UXO Tech II (8% hazard)	249,683	hours	$45.67	$11,403,017.13
UXO Tech III	33,233	hours	$50.69	$1,684,599.02
UXO Tech III (4% hazard)	1,736	hours	$52.72	$91,521.92
UXO Tech III (8% hazard)	124,845	hours	$54.75	$6,835,287.84
Senior UXO Supervisor	34,981	hours	$63.11	$2,207,673.63
Senior UXO Supervisor (4% hazard)	1,104	hours	$66.21	$73,095.84
Senior UXO Supervisor (8% hazard)	124,845	hours	$68.76	$8,584,372.45
UXO Safety Officer	34,953	hours	$59.78	$2,089,511.86
UXO Safety Officer (4% hazard)	1,104	hours	$62.72	$69,242.88
UXO Safety Officer (8% hazard)	125,005	hours	$65.14	$8,142,854.36
UXO Quality Control Specialist	34,953	hours	$57.14	$1,997,234.99
UXO Quality Control Specialist (4% hazard)	1,092	hours	$59.93	$65,443.56
UXO Quality Control Specialist (8% hazard)	124,837	hours	$62.25	$7,771,130.64
Total Labor (Field Site)	**1,500,987**	**hours**		**$74,223,083.03**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,914,054.63	$3,914,054.63
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$5,812,773.71**
Subtotal				**$80,462,631.19**
G&A (excluding labor) @ 7.99%				$414,450.77
Subtotal (excluding fee)				**$80,877,081.95**
Fee (excluding labor & travel) @ 4.00%				$178,522.30
Fee (on labor) @ 8.00%				$5,971,988.60
Total Capital Costs				**$87,027,592.86**
Alternative Net Present Value [3]				**$87,027,592.86**
Lower End of TPV Range at -35%				**$56,567,935.36**
Upper End of TPV Range at +50%				**$130,541,389.28**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	1,353	hours	$156.27	$211,433.31
Site Geophysicist	9,311	hours	$107.41	$1,000,115.99
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**11,388**	**hours**		**$1,302,690.74**
Labor Category (Field Site)				
UXO Tech I	33,642	hours	$34.96	$1,176,141.55
UXO Tech I (8% hazard)	63,450	hours	$37.76	$2,395,870.91
UXO Tech II	36,965	hours	$42.29	$1,563,249.65
UXO Tech II (4% hazard)	28,096	hours	$43.98	$1,235,662.08
UXO Tech II (8% hazard)	42,300	hours	$45.67	$1,931,840.12
UXO Tech III	7,037	hours	$50.69	$356,730.75
UXO Tech III (8% hazard)	21,150	hours	$54.75	$1,157,961.97
Senior UXO Supervisor	6,941	hours	$63.11	$438,077.91
Senior UXO Supervisor (4% hazard)	1,752	hours	$66.21	$115,999.92
Senior UXO Supervisor (8% hazard)	19,990	hours	$68.76	$1,374,511.74
UXO Safety Officer	8,173	hours	$59.78	$488,611.69
UXO Safety Officer (4% hazard)	1,752	hours	$62.72	$109,885.44
UXO Safety Officer (8% hazard)	19,990	hours	$65.14	$1,302,147.97
UXO Quality Control Specialist	8,153	hours	$57.14	$465,890.85
UXO Quality Control Specialist (4% hazard)	1,752	hours	$59.93	$104,997.36
UXO Quality Control Specialist (8% hazard)	19,990	hours	$62.25	$1,244,376.90
Total Labor (Field Site)	**321,135**	**hours**		**$15,461,956.83**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,897,857.37	$3,897,857.37
Travel Costs [2]	1	lump sum	$1,673,793.42	$1,673,793.42
Subcontractor Costs	1	lump sum	$325,106.65	$325,106.65
Total				**$5,896,757.44**
Subtotal				**$22,661,405.01**
G&A (excluding labor) @ 7.99%				$420,438.81
Subtotal (excluding fee)				**$23,081,843.82**
Fee (excluding labor & travel) @ 4.00%				$185,736.11
Fee (on labor) @ 8.00%				$1,341,171.81
Total Capital Costs				**$24,608,751.73**
Alternative Net Present Value [3]				**$24,608,751.73**
Lower End of TPV Range at -35%				**$15,995,688.63**
Upper End of TPV Range at +50%				**$36,913,127.60**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-02, 391 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-02, 391 acres	$ 14,905,935	$ 39,142	$ 201,560	$ 15,146,637	$ 14,993,081	$ 9,745,503	$ 22,489,622
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-02, 391 acres	$ 25,525,516	$ -	$ -	$ 25,525,516	$ 25,525,516	$ 16,591,586	$ 38,288,275
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-02, 391 acres	$ 7,196,845	$ -	$ -	$ 7,196,845	$ 7,196,845	$ 4,677,949	$ 10,795,268

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) (1)	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs (2)	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance (3)	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report (4)	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value (5)				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

(1) Includes development of Work Plan and supporting documents, and home office support during field work.

(2) Includes lodging, airfare, and M&IE for field work.

(3) Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

(4) Includes all travel, labor, and equipment for site visit and report preparation.

(5) TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	90	hours	$150.94	$13,580.03
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	30	hours	$55.78	$1,671.71
Total Labor (Home Site) [(1)]	**558**	**hours**		**$65,888.82**
Labor Category (Field Site)				
UXO Tech I	17,551	hours	$34.96	$613,582.96
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	4,012	hours	$37.76	$151,493.12
UXO Tech II	11,797	hours	$42.29	$498,890.01
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	2,771	hours	$45.67	$126,551.57
UXO Tech III	5,863	hours	$50.69	$297,195.47
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	1,434	hours	$54.75	$78,511.50
Senior UXO Supervisor	112	hours	$63.11	$7,064.50
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	288	hours	$68.76	$19,802.88
UXO Safety Officer	100	hours	$59.78	$5,978.00
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	288	hours	$65.14	$18,760.32
UXO Quality Control Specialist	100	hours	$57.14	$5,714.00
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	288	hours	$62.25	$17,928.00
Total Labor (Field Site)	**174,508**	**hours**		**$7,250,343.05**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,459,772.26	$1,459,772.26
Travel Costs [(2)]	1	lump sum	$2,536,449.56	$2,536,449.56
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$6,377,821.82**
Subtotal				**$13,694,053.69**
G&A (excluding labor) @ 7.99%				$454,738.70
Subtotal (excluding fee)				**$14,148,792.39**
Fee (excluding labor & travel) @ 4.00%				$171,844.44
Fee (on labor) @ 8.00%				$585,298.55
Total Capital Costs				**$14,905,935.38**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$14,993,081.25**
Lower End of TPV Range at -35%				**$9,745,502.81**
Upper End of TPV Range at +50%				**$22,489,621.88**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	154	hours	$156.27	$24,065.58
Site Geophysicist	695	hours	$107.41	$74,649.95
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**1,601**	**hours**		**$193,702.65**
Labor Category (Field Site)				
UXO Tech I	28,922	hours	$34.96	$1,011,124.31
UXO Tech I (4% hazard)	3,792	hours	$36.36	$137,877.12
UXO Tech I (8% hazard)	102,977	hours	$37.76	$3,888,422.09
UXO Tech II	28,889	hours	$42.29	$1,221,710.74
UXO Tech II (4% hazard)	3,064	hours	$43.98	$134,754.72
UXO Tech II (8% hazard)	68,324	hours	$45.67	$3,120,335.16
UXO Tech III	9,205	hours	$50.69	$466,623.75
UXO Tech III (4% hazard)	504	hours	$52.72	$26,570.88
UXO Tech III (8% hazard)	34,166	hours	$54.75	$1,870,575.36
Senior UXO Supervisor	9,631	hours	$63.11	$607,840.18
Senior UXO Supervisor (4% hazard)	328	hours	$66.21	$21,716.88
Senior UXO Supervisor (8% hazard)	34,166	hours	$68.76	$2,349,237.66
UXO Safety Officer	9,603	hours	$59.78	$574,093.64
UXO Safety Officer (4% hazard)	328	hours	$62.72	$20,572.16
UXO Safety Officer (8% hazard)	34,326	hours	$65.14	$2,235,980.01
UXO Quality Control Specialist	9,603	hours	$57.14	$548,740.56
UXO Quality Control Specialist (4% hazard)	316	hours	$59.93	$18,937.88
UXO Quality Control Specialist (8% hazard)	34,158	hours	$62.25	$2,126,320.56
Total Labor (Field Site)	**412,303**	**hours**		**$20,381,433.65**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,130,433.10	$1,130,433.10
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$3,029,152.18**
Subtotal				**$23,604,288.48**
G&A (excluding labor) @ 7.99%				$215,978.55
Subtotal (excluding fee)				**$23,820,267.03**
Fee (excluding labor & travel) @ 4.00%				$59,238.55
Fee (on labor) @ 8.00%				$1,646,010.90
Total Capital Costs				**$25,525,516.49**
Alternative Net Present Value [3]				**$25,525,516.49**
Lower End of TPV Range at -35%				**$16,591,585.72**
Upper End of TPV Range at +50%				**$38,288,274.73**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	375	hours	$156.27	$58,601.25
Site Geophysicist	2,590	hours	$107.41	$278,234.86
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**3,689**	**hours**		**$427,977.55**
Labor Category (Field Site)				
UXO Tech I	9,489	hours	$34.96	$331,733.03
UXO Tech I (8% hazard)	17,404	hours	$37.76	$657,164.65
UXO Tech II	10,545	hours	$42.29	$445,932.01
UXO Tech II (4% hazard)	7,880	hours	$43.98	$346,562.40
UXO Tech II (8% hazard)	11,602	hours	$45.67	$529,885.41
UXO Tech III	2,150	hours	$50.69	$108,999.23
UXO Tech III (8% hazard)	5,801	hours	$54.75	$317,617.98
Senior UXO Supervisor	2,076	hours	$63.11	$131,035.95
Senior UXO Supervisor (4% hazard)	504	hours	$66.21	$33,369.84
Senior UXO Supervisor (8% hazard)	5,481	hours	$68.76	$376,890.17
UXO Safety Officer	2,278	hours	$59.78	$136,197.40
UXO Safety Officer (4% hazard)	504	hours	$62.72	$31,610.88
UXO Safety Officer (8% hazard)	5,481	hours	$65.14	$357,048.08
UXO Quality Control Specialist	2,258	hours	$57.14	$129,039.86
UXO Quality Control Specialist (4% hazard)	504	hours	$59.93	$30,204.72
UXO Quality Control Specialist (8% hazard)	5,481	hours	$62.25	$341,207.29
Total Labor (Field Site)	**89,440**	**hours**		**$4,304,498.90**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,236,575.45	$1,236,575.45
Travel Costs [2]	1	lump sum	$546,805.54	$546,805.54
Subcontractor Costs	1	lump sum	$108,320.35	$108,320.35
Total				**$1,891,701.34**
Subtotal				**$6,624,177.79**
G&A (excluding labor) @ 7.99%				$134,878.31
Subtotal (excluding fee)				**$6,759,056.10**
Fee (excluding labor & travel) @ 4.00%				$59,190.96
Fee (on labor) @ 8.00%				$378,598.12
Total Capital Costs				**$7,196,845.18**
Alternative Net Present Value [3]				**$7,196,845.18**
Lower End of TPV Range at -35%				**$4,677,949.37**
Upper End of TPV Range at +50%				**$10,795,267.77**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-03, 924 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-03, 924 acres	$ 15,954,806	$ 39,142	$ 201,560	$ 16,195,509	$ 16,041,952	$ 10,427,269	$ 24,062,928
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-03, 924 acres	$ 57,116,189	$ -	$ -	$ 57,116,189	$ 57,116,189	$ 37,125,523	$ 85,674,284
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-03, 924 acres	$ 16,119,846	$ -	$ -	$ 16,119,846	$ 16,119,846	$ 10,477,900	$ 24,179,769

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) [1]	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs [2]	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report [4]	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value [5]				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

[1] Includes development of Work Plan and supporting documents, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	98	hours	$150.94	$14,808.35
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	38	hours	$55.78	$2,125.64
Total Labor (Home Site) [(1)]	**574**	**hours**		**$67,571.06**
Labor Category (Field Site)				
UXO Tech I	18,919	hours	$34.96	$661,408.24
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	9,481	hours	$37.76	$358,002.56
UXO Tech II	12,758	hours	$42.29	$539,554.00
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	6,547	hours	$45.67	$299,001.49
UXO Tech III	6,336	hours	$50.69	$321,171.84
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	3,387	hours	$54.75	$185,438.25
Senior UXO Supervisor	210	hours	$63.11	$13,266.67
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	678	hours	$68.76	$46,619.28
UXO Safety Officer	182	hours	$59.78	$10,879.96
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	678	hours	$65.14	$44,164.92
UXO Quality Control Specialist	182	hours	$57.14	$10,399.48
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	678	hours	$62.25	$42,205.50
Total Labor (Field Site)	**189,941**	**hours**		**$7,940,982.91**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,537,540.90	$1,537,540.90
Travel Costs [(2)]	1	lump sum	$2,736,157.91	$2,736,157.91
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$6,655,298.81**
Subtotal				**$14,663,852.79**
G&A (excluding labor) @ 7.99%				$474,522.81
Subtotal (excluding fee)				**$15,138,375.59**
Fee (excluding labor & travel) @ 4.00%				$175,746.55
Fee (on labor) @ 8.00%				$640,684.32
Total Capital Costs				**$15,954,806.46**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$16,041,952.33**
Lower End of TPV Range at -35%				**$10,427,269.02**
Upper End of TPV Range at +50%				**$24,062,928.50**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	312	hours	$156.27	$48,756.24
Site Geophysicist	1,574	hours	$107.41	$169,063.34
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**2,638**	**hours**		**$312,806.70**
Labor Category (Field Site)				
UXO Tech I	67,848	hours	$34.96	$2,371,982.86
UXO Tech I (4% hazard)	8,608	hours	$36.36	$312,986.88
UXO Tech I (8% hazard)	243,338	hours	$37.76	$9,188,439.86
UXO Tech II	67,556	hours	$42.29	$2,856,956.77
UXO Tech II (4% hazard)	6,928	hours	$43.98	$304,693.44
UXO Tech II (8% hazard)	161,449	hours	$45.67	$7,373,388.62
UXO Tech III	21,574	hours	$50.69	$1,093,594.17
UXO Tech III (4% hazard)	1,176	hours	$52.72	$61,998.72
UXO Tech III (8% hazard)	80,729	hours	$54.75	$4,419,893.04
Senior UXO Supervisor	22,642	hours	$63.11	$1,428,946.72
Senior UXO Supervisor (4% hazard)	728	hours	$66.21	$48,200.88
Senior UXO Supervisor (8% hazard)	80,729	hours	$68.76	$5,550,901.29
UXO Safety Officer	22,614	hours	$59.78	$1,351,874.48
UXO Safety Officer (4% hazard)	728	hours	$62.72	$45,660.16
UXO Safety Officer (8% hazard)	80,889	hours	$65.14	$5,269,086.01
UXO Quality Control Specialist	22,614	hours	$57.14	$1,292,173.10
UXO Quality Control Specialist (4% hazard)	716	hours	$59.93	$42,909.88
UXO Quality Control Specialist (8% hazard)	80,721	hours	$62.25	$5,024,859.84
Total Labor (Field Site)	**971,587**	**hours**		**$48,038,546.72**
Other Direct Costs (field equipment / rentals)	1	lump sum	$2,559,644.27	$2,559,644.27
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$4,458,363.35**
Subtotal				**$52,809,716.77**
G&A (excluding labor) @ 7.99%				$317,881.31
Subtotal (excluding fee)				**$53,127,598.07**
Fee (excluding labor & travel) @ 4.00%				$120,483.11
Fee (on labor) @ 8.00%				$3,868,108.27
Total Capital Costs				**$57,116,189.46**
Alternative Net Present Value [3]				**$57,116,189.46**
Lower End of TPV Range at -35%				**$37,125,523.15**
Upper End of TPV Range at +50%				**$85,674,284.19**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	868	hours	$156.27	$135,642.36
Site Geophysicist	5,995	hours	$107.41	$643,901.47
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**7,587**	**hours**		**$870,685.27**
Labor Category (Field Site)				
UXO Tech I	21,922	hours	$34.96	$766,409.79
UXO Tech I (8% hazard)	41,098	hours	$37.76	$1,551,856.98
UXO Tech II	24,126	hours	$42.29	$1,020,273.79
UXO Tech II (4% hazard)	18,128	hours	$43.98	$797,269.44
UXO Tech II (8% hazard)	27,399	hours	$45.67	$1,251,294.28
UXO Tech III	4,685	hours	$50.69	$237,473.81
UXO Tech III (8% hazard)	13,699	hours	$54.75	$750,036.81
Senior UXO Supervisor	4,577	hours	$63.11	$288,843.46
Senior UXO Supervisor (4% hazard)	1,136	hours	$66.21	$75,214.56
Senior UXO Supervisor (8% hazard)	12,931	hours	$68.76	$889,156.35
UXO Safety Officer	5,309	hours	$59.78	$317,361.59
UXO Safety Officer (4% hazard)	1,136	hours	$62.72	$71,249.92
UXO Safety Officer (8% hazard)	12,931	hours	$65.14	$842,345.04
UXO Quality Control Specialist	5,289	hours	$57.14	$302,203.49
UXO Quality Control Specialist (4% hazard)	1,136	hours	$59.93	$68,080.48
UXO Quality Control Specialist (8% hazard)	12,931	hours	$62.25	$804,973.57
Total Labor (Field Site)	**208,433**	**hours**		**$10,034,043.37**
Other Direct Costs (field equipment / rentals)	1	lump sum	$2,592,505.50	$2,592,505.50
Travel Costs [2]	1	lump sum	$1,126,082.83	$1,126,082.83
Subcontractor Costs	1	lump sum	$219,637.40	$219,637.40
Total				**$3,938,225.73**
Subtotal				**$14,842,954.37**
G&A (excluding labor) @ 7.99%				$280,795.49
Subtotal (excluding fee)				**$15,123,749.86**
Fee (excluding labor & travel) @ 4.00%				$123,717.54
Fee (on labor) @ 8.00%				$872,378.29
Total Capital Costs				**$16,119,845.69**
Alternative Net Present Value [3]				**$16,119,845.69**
Lower End of TPV Range at -35%				**$10,477,899.70**
Upper End of TPV Range at +50%				**$24,179,768.53**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-04, 2202 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-04, 2202 acres	$ 18,471,234	$ 39,142	$ 201,560	$ 18,711,936	$ 18,558,380	$ 12,062,947	$ 27,837,569
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-04, 2202 acres	$ 132,773,591	$ -	$ -	$ 132,773,591	$ 132,773,591	$ 86,302,834	$ 199,160,387
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-04, 2202 acres	$ 37,456,528	$ -	$ -	$ 37,456,528	$ 37,456,528	$ 24,346,743	$ 56,184,793

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) (1)	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs (2)	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance (3)	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report (4)	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value (5)				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

(1) Includes development of Work Plan and supporting documents, and home office support during field work.

(2) Includes lodging, airfare, and M&IE for field work.

(3) Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

(4) Includes all travel, labor, and equipment for site visit and report preparation.

(5) TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	118	hours	$150.94	$17,753.54
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	58	hours	$55.78	$3,214.03
Total Labor (Home Site) [(1)]	**613**	**hours**		**$71,604.65**
Labor Category (Field Site)				
UXO Tech I	22,197	hours	$34.96	$776,007.12
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	22,593	hours	$37.76	$853,111.68
UXO Tech II	15,060	hours	$42.29	$636,907.67
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	15,600	hours	$45.67	$712,452.00
UXO Tech III	7,467	hours	$50.69	$378,502.23
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	8,069	hours	$54.75	$441,777.75
Senior UXO Supervisor	444	hours	$63.11	$28,035.96
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	1,614	hours	$68.76	$110,978.64
UXO Safety Officer	377	hours	$59.78	$22,537.06
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	1,614	hours	$65.14	$105,135.96
UXO Quality Control Specialist	377	hours	$57.14	$21,541.78
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	1,614	hours	$62.25	$100,471.50
Total Labor (Field Site)	**226,931**	**hours**		**$9,596,330.07**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,724,720.92	$1,724,720.92
Travel Costs [(2)]	1	lump sum	$3,216,303.26	$3,216,303.26
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$7,322,624.18**
Subtotal				**$16,990,558.90**
G&A (excluding labor) @ 7.99%				$522,103.10
Subtotal (excluding fee)				**$17,512,662.01**
Fee (excluding labor & travel) @ 4.00%				$185,136.96
Fee (on labor) @ 8.00%				$773,434.78
Total Capital Costs				**$18,471,233.75**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$18,558,379.62**
Lower End of TPV Range at -35%				**$12,062,946.75**
Upper End of TPV Range at +50%				**$27,837,569.43**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	694	hours	$156.27	$108,451.38
Site Geophysicist	3,675	hours	$107.41	$394,731.75
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**5,121**	**hours**		**$598,170.25**
Labor Category (Field Site)				
UXO Tech I	160,935	hours	$34.96	$5,626,289.00
UXO Tech I (4% hazard)	19,584	hours	$36.36	$712,074.24
UXO Tech I (8% hazard)	579,620	hours	$37.76	$21,886,457.24
UXO Tech II	160,213	hours	$42.29	$6,775,422.99
UXO Tech II (4% hazard)	15,832	hours	$43.98	$696,291.36
UXO Tech II (8% hazard)	384,741	hours	$45.67	$17,571,141.56
UXO Tech III	51,110	hours	$50.69	$2,590,749.68
UXO Tech III (4% hazard)	2,632	hours	$52.72	$138,759.04
UXO Tech III (8% hazard)	192,375	hours	$54.75	$10,532,515.92
Senior UXO Supervisor	53,824	hours	$63.11	$3,396,812.44
Senior UXO Supervisor (4% hazard)	1,672	hours	$66.21	$110,703.12
Senior UXO Supervisor (8% hazard)	192,375	hours	$68.76	$13,227,685.75
UXO Safety Officer	53,796	hours	$59.78	$3,215,905.75
UXO Safety Officer (4% hazard)	1,672	hours	$62.72	$104,867.84
UXO Safety Officer (8% hazard)	192,535	hours	$65.14	$12,541,711.66
UXO Quality Control Specialist	53,796	hours	$57.14	$3,073,885.16
UXO Quality Control Specialist (4% hazard)	1,660	hours	$59.93	$99,483.80
UXO Quality Control Specialist (8% hazard)	192,367	hours	$62.25	$11,974,828.32
Total Labor (Field Site)	**2,310,738**	**hours**		**$114,275,584.88**
Other Direct Costs (field equipment / rentals)	1	lump sum	$5,982,164.54	$5,982,164.54
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$7,880,883.62**
Subtotal				**$122,754,638.74**
G&A (excluding labor) @ 7.99%				$561,907.00
Subtotal (excluding fee)				**$123,316,545.74**
Fee (excluding labor & travel) @ 4.00%				$267,144.95
Fee (on labor) @ 8.00%				$9,189,900.41
Total Capital Costs				**$132,773,591.10**
Alternative Net Present Value [3]				**$132,773,591.10**
Lower End of TPV Range at -35%				**$86,302,834.22**
Upper End of TPV Range at +50%				**$199,160,386.66**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	2,055	hours	$156.27	$321,134.85
Site Geophysicist	14,164	hours	$107.41	$1,521,398.20
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**16,943**	**hours**		**$1,933,674.49**
Labor Category (Field Site)				
UXO Tech I	51,574	hours	$34.96	$1,803,027.26
UXO Tech I (8% hazard)	97,712	hours	$37.76	$3,689,606.09
UXO Tech II	56,479	hours	$42.29	$2,388,511.19
UXO Tech II (4% hazard)	42,768	hours	$43.98	$1,880,936.64
UXO Tech II (8% hazard)	65,141	hours	$45.67	$2,975,005.47
UXO Tech III	10,663	hours	$50.69	$540,490.68
UXO Tech III (8% hazard)	32,571	hours	$54.75	$1,783,244.47
Senior UXO Supervisor	10,549	hours	$63.11	$665,726.49
Senior UXO Supervisor (4% hazard)	2,664	hours	$66.21	$176,383.44
Senior UXO Supervisor (8% hazard)	30,795	hours	$68.76	$2,117,441.87
UXO Safety Officer	12,551	hours	$59.78	$750,278.98
UXO Safety Officer (4% hazard)	2,664	hours	$62.72	$167,086.08
UXO Safety Officer (8% hazard)	30,795	hours	$65.14	$2,005,965.14
UXO Quality Control Specialist	12,531	hours	$57.14	$716,002.42
UXO Quality Control Specialist (4% hazard)	2,664	hours	$59.93	$159,653.52
UXO Quality Control Specialist (8% hazard)	30,795	hours	$62.25	$1,916,968.53
Total Labor (Field Site)	**492,914**	**hours**		**$23,736,328.26**
Other Direct Costs (field equipment / rentals)	1	lump sum	$5,843,210.09	$5,843,210.09
Travel Costs [2]	1	lump sum	$2,495,562.14	$2,495,562.14
Subcontractor Costs	1	lump sum	$486,547.70	$486,547.70
Total				**$8,825,319.93**
Subtotal				**$34,495,322.69**
G&A (excluding labor) @ 7.99%				$629,245.31
Subtotal (excluding fee)				**$35,124,568.00**
Fee (excluding labor & travel) @ 4.00%				$278,360.12
Fee (on labor) @ 8.00%				$2,053,600.22
Total Capital Costs				**$37,456,528.34**
Alternative Net Present Value [3]				**$37,456,528.34**
Lower End of TPV Range at -35%				**$24,346,743.42**
Upper End of TPV Range at +50%				**$56,184,792.51**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-05, 1807 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-05, 1807 acres	$ 17,695,858	$ 39,142	$ 201,560	$ 17,936,560	$ 17,783,004	$ 11,558,952	$ 26,674,505
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-05, 1807 acres	$ 109,387,091	$ -	$ -	$ 109,387,091	$ 109,387,091	$ 71,101,609	$ 164,080,636
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-05, 1807 acres	$ 30,865,435	$ -	$ -	$ 30,865,435	$ 30,865,435	$ 20,062,533	$ 46,298,152

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) [1]	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs [2]	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report [4]	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value [5]				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

[1] Includes development of Work Plan and supporting documents, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	112	hours	$150.94	$16,843.25
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	52	hours	$55.78	$2,877.64
Total Labor (Home Site) [(1)]	**601**	**hours**		**$70,357.96**
Labor Category (Field Site)				
UXO Tech I	21,183	hours	$34.96	$740,557.68
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	18,540	hours	$37.76	$700,070.40
UXO Tech II	14,348	hours	$42.29	$606,791.98
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	12,802	hours	$45.67	$584,667.34
UXO Tech III	7,117	hours	$50.69	$360,760.73
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	6,622	hours	$54.75	$362,554.50
Senior UXO Supervisor	372	hours	$63.11	$23,488.16
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	1,325	hours	$68.76	$91,107.00
UXO Safety Officer	317	hours	$59.78	$18,950.26
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	1,325	hours	$65.14	$86,310.50
UXO Quality Control Specialist	317	hours	$57.14	$18,113.38
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	1,325	hours	$62.25	$82,481.25
Total Labor (Field Site)	**215,498**	**hours**		**$9,084,723.89**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,667,664.56	$1,667,664.56
Travel Costs [(2)]	1	lump sum	$3,069,279.86	$3,069,279.86
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$7,118,544.42**
Subtotal				**$16,273,626.28**
G&A (excluding labor) @ 7.99%				$507,552.22
Subtotal (excluding fee)				**$16,781,178.49**
Fee (excluding labor & travel) @ 4.00%				$182,272.67
Fee (on labor) @ 8.00%				$732,406.55
Total Capital Costs				**$17,695,857.71**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$17,783,003.59**
Lower End of TPV Range at -35%				**$11,558,952.33**
Upper End of TPV Range at +50%				**$26,674,505.38**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	578	hours	$156.27	$90,324.06
Site Geophysicist	3,037	hours	$107.41	$326,204.17
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**4,367**	**hours**		**$511,515.35**
Labor Category (Field Site)				
UXO Tech I	132,157	hours	$34.96	$4,620,196.13
UXO Tech I (4% hazard)	16,056	hours	$36.36	$583,796.16
UXO Tech I (8% hazard)	475,595	hours	$37.76	$17,958,450.59
UXO Tech II	131,718	hours	$42.29	$5,570,344.07
UXO Tech II (4% hazard)	13,088	hours	$43.98	$575,610.24
UXO Tech II (8% hazard)	315,727	hours	$45.67	$14,419,253.92
UXO Tech III	41,937	hours	$50.69	$2,125,780.45
UXO Tech III (4% hazard)	2,128	hours	$52.72	$112,188.16
UXO Tech III (8% hazard)	157,868	hours	$54.75	$8,643,246.72
Senior UXO Supervisor	44,197	hours	$63.11	$2,789,265.10
Senior UXO Supervisor (4% hazard)	1,384	hours	$66.21	$91,634.64
Senior UXO Supervisor (8% hazard)	157,868	hours	$68.76	$10,854,970.68
UXO Safety Officer	44,169	hours	$59.78	$2,640,415.65
UXO Safety Officer (4% hazard)	1,384	hours	$62.72	$86,804.48
UXO Safety Officer (8% hazard)	158,028	hours	$65.14	$10,293,912.65
UXO Quality Control Specialist	44,169	hours	$57.14	$2,523,809.80
UXO Quality Control Specialist (4% hazard)	1,372	hours	$59.93	$82,223.96
UXO Quality Control Specialist (8% hazard)	157,860	hours	$62.25	$9,826,755.12
Total Labor (Field Site)	**1,896,702**	**hours**		**$93,798,658.51**
Other Direct Costs (field equipment / rentals)	1	lump sum	$4,925,008.43	$4,925,008.43
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$6,823,727.51**
Subtotal				**$101,133,901.36**
G&A (excluding labor) @ 7.99%				$486,531.77
Subtotal (excluding fee)				**$101,620,433.14**
Fee (excluding labor & travel) @ 4.00%				$221,843.70
Fee (on labor) @ 8.00%				$7,544,813.91
Total Capital Costs				**$109,387,090.74**
Alternative Net Present Value [3]				**$109,387,090.74**
Lower End of TPV Range at -35%				**$71,101,608.98**
Upper End of TPV Range at +50%				**$164,080,636.11**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	1,693	hours	$156.27	$264,565.11
Site Geophysicist	11,661	hours	$107.41	$1,252,529.49
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**14,078**	**hours**		**$1,608,236.04**
Labor Category (Field Site)				
UXO Tech I	42,365	hours	$34.96	$1,481,085.38
UXO Tech I (8% hazard)	80,141	hours	$37.76	$3,026,107.91
UXO Tech II	46,453	hours	$42.29	$1,964,487.29
UXO Tech II (4% hazard)	35,320	hours	$43.98	$1,553,373.60
UXO Tech II (8% hazard)	53,427	hours	$45.67	$2,440,013.21
UXO Tech III	8,778	hours	$50.69	$444,976.12
UXO Tech III (8% hazard)	26,714	hours	$54.75	$1,462,565.40
Senior UXO Supervisor	8,704	hours	$63.11	$549,333.47
Senior UXO Supervisor (4% hazard)	2,200	hours	$66.21	$145,662.00
Senior UXO Supervisor (8% hazard)	25,274	hours	$68.76	$1,737,807.46
UXO Safety Officer	10,306	hours	$59.78	$616,115.44
UXO Safety Officer (4% hazard)	2,200	hours	$62.72	$137,984.00
UXO Safety Officer (8% hazard)	25,274	hours	$65.14	$1,646,317.30
UXO Quality Control Specialist	10,286	hours	$57.14	$587,763.80
UXO Quality Control Specialist (4% hazard)	2,200	hours	$59.93	$131,846.00
UXO Quality Control Specialist (8% hazard)	25,274	hours	$62.25	$1,573,276.82
Total Labor (Field Site)	**404,915**	**hours**		**$19,498,715.19**
Other Direct Costs (field equipment / rentals)	1	lump sum	$4,840,655.26	$4,840,655.26
Travel Costs [2]	1	lump sum	$2,072,822.52	$2,072,822.52
Subcontractor Costs	1	lump sum	$404,051.95	$404,051.95
Total				**$7,317,529.73**
Subtotal				**$28,424,480.96**
G&A (excluding labor) @ 7.99%				$521,739.87
Subtotal (excluding fee)				**$28,946,220.83**
Fee (excluding labor & travel) @ 4.00%				$230,657.88
Fee (on labor) @ 8.00%				$1,688,556.10
Total Capital Costs				**$30,865,434.82**
Alternative Net Present Value [3]				**$30,865,434.82**
Lower End of TPV Range at -35%				**$20,062,532.63**
Upper End of TPV Range at +50%				**$46,298,152.22**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-06, 1451 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-06, 1451 acres	$ 16,994,920	$ 39,142	$ 201,560	$ 17,235,622	$ 17,082,066	$ 11,103,343	$ 25,623,099
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-06, 1451 acres	$ 88,287,386	$ -	$ -	$ 88,287,386	$ 88,287,386	$ 57,386,801	$ 132,431,080
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-06, 1451 acres	$ 24,888,992	$ -	$ -	$ 24,888,992	$ 24,888,992	$ 16,177,845	$ 37,333,489

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) (1)	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs (2)	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance (3)	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report (4)	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value (5)				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

(1) Includes development of Work Plan and supporting documents, and home office support during field work.

(2) Includes lodging, airfare, and M&IE for field work.

(3) Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

(4) Includes all travel, labor, and equipment for site visit and report preparation.

(5) TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	106	hours	$150.94	$16,022.83
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	46	hours	$55.78	$2,574.45
Total Labor (Home Site) [(1)]	**590**	**hours**		**$69,234.36**
Labor Category (Field Site)				
UXO Tech I	20,270	hours	$34.96	$708,639.20
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	14,888	hours	$37.76	$562,170.88
UXO Tech II	13,708	hours	$42.29	$579,695.02
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	10,280	hours	$45.67	$469,487.60
UXO Tech III	6,802	hours	$50.69	$344,793.38
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	5,318	hours	$54.75	$291,160.50
Senior UXO Supervisor	307	hours	$63.11	$19,394.17
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	1,064	hours	$68.76	$73,160.64
UXO Safety Officer	263	hours	$59.78	$15,722.14
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	1,064	hours	$65.14	$69,308.96
UXO Quality Control Specialist	263	hours	$57.14	$15,027.82
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	1,064	hours	$62.25	$66,234.00
Total Labor (Field Site)	**205,195**	**hours**		**$8,623,665.03**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,615,181.30	$1,615,181.30
Travel Costs [(2)]	1	lump sum	$2,935,866.26	$2,935,866.26
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$6,932,647.56**
Subtotal				**$15,625,546.95**
G&A (excluding labor) @ 7.99%				$494,297.77
Subtotal (excluding fee)				**$16,119,844.72**
Fee (excluding labor & travel) @ 4.00%				$179,643.16
Fee (on labor) @ 8.00%				$695,431.95
Total Capital Costs				**$16,994,919.84**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$17,082,065.71**
Lower End of TPV Range at -35%				**$11,103,342.71**
Upper End of TPV Range at +50%				**$25,623,098.57**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	470	hours	$156.27	$73,446.90
Site Geophysicist	2,433	hours	$107.41	$261,328.53
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**3,655**	**hours**		**$429,762.55**
Labor Category (Field Site)				
UXO Tech I	106,158	hours	$34.96	$3,711,266.90
UXO Tech I (4% hazard)	12,976	hours	$36.36	$471,807.36
UXO Tech I (8% hazard)	381,958	hours	$37.76	$14,422,737.10
UXO Tech II	105,710	hours	$42.29	$4,470,462.37
UXO Tech II (4% hazard)	10,512	hours	$43.98	$462,317.76
UXO Tech II (8% hazard)	253,527	hours	$45.67	$11,578,565.30
UXO Tech III	33,714	hours	$50.69	$1,708,954.55
UXO Tech III (4% hazard)	1,736	hours	$52.72	$91,521.92
UXO Tech III (8% hazard)	126,767	hours	$54.75	$6,940,512.96
Senior UXO Supervisor	35,492	hours	$63.11	$2,239,890.02
Senior UXO Supervisor (4% hazard)	1,112	hours	$66.21	$73,625.52
Senior UXO Supervisor (8% hazard)	126,767	hours	$68.76	$8,716,523.67
UXO Safety Officer	35,464	hours	$59.78	$2,120,028.36
UXO Safety Officer (4% hazard)	1,112	hours	$62.72	$69,744.64
UXO Safety Officer (8% hazard)	126,927	hours	$65.14	$8,268,048.23
UXO Quality Control Specialist	35,464	hours	$57.14	$2,026,403.82
UXO Quality Control Specialist (4% hazard)	1,100	hours	$59.93	$65,923.00
UXO Quality Control Specialist (8% hazard)	126,759	hours	$62.25	$7,890,770.16
Total Labor (Field Site)	**1,523,255**	**hours**		**$75,329,103.64**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,969,759.90	$3,969,759.90
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$5,868,478.98**
Subtotal				**$81,627,345.16**
G&A (excluding labor) @ 7.99%				$418,422.55
Subtotal (excluding fee)				**$82,045,767.71**
Fee (excluding labor & travel) @ 4.00%				$180,909.39
Fee (on labor) @ 8.00%				$6,060,709.30
Total Capital Costs				**$88,287,386.40**
Alternative Net Present Value [3]				**$88,287,386.40**
Lower End of TPV Range at -35%				**$57,386,801.16**
Upper End of TPV Range at +50%				**$132,431,079.59**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	1,359	hours	$156.27	$212,370.93
Site Geophysicist	9,363	hours	$107.41	$1,005,701.31
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**11,446**	**hours**		**$1,309,213.68**
Labor Category (Field Site)				
UXO Tech I	34,069	hours	$34.96	$1,191,056.55
UXO Tech I (8% hazard)	64,372	hours	$37.76	$2,430,705.33
UXO Tech II	37,371	hours	$42.29	$1,580,408.97
UXO Tech II (4% hazard)	28,320	hours	$43.98	$1,245,513.60
UXO Tech II (8% hazard)	42,915	hours	$45.67	$1,959,927.83
UXO Tech III	7,114	hours	$50.69	$360,627.64
UXO Tech III (8% hazard)	21,457	hours	$54.75	$1,174,797.99
Senior UXO Supervisor	7,030	hours	$63.11	$443,686.93
Senior UXO Supervisor (4% hazard)	1,768	hours	$66.21	$117,059.28
Senior UXO Supervisor (8% hazard)	20,297	hours	$68.76	$1,395,655.93
UXO Safety Officer	8,282	hours	$59.78	$495,120.34
UXO Safety Officer (4% hazard)	1,768	hours	$62.72	$110,888.96
UXO Safety Officer (8% hazard)	20,297	hours	$65.14	$1,322,178.99
UXO Quality Control Specialist	8,262	hours	$57.14	$472,112.07
UXO Quality Control Specialist (4% hazard)	1,768	hours	$59.93	$105,956.24
UXO Quality Control Specialist (8% hazard)	20,297	hours	$62.25	$1,263,519.23
Total Labor (Field Site)	**325,391**	**hours**		**$15,669,215.88**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,926,923.13	$3,926,923.13
Travel Costs [2]	1	lump sum	$1,684,828.35	$1,684,828.35
Subcontractor Costs	1	lump sum	$329,701.35	$329,701.35
Total				**$5,941,452.83**
Subtotal				**$22,919,882.39**
G&A (excluding labor) @ 7.99%				$423,625.59
Subtotal (excluding fee)				**$23,343,507.98**
Fee (excluding labor & travel) @ 4.00%				$187,210.00
Fee (on labor) @ 8.00%				$1,358,274.37
Total Capital Costs				**$24,888,992.35**
Alternative Net Present Value [3]				**$24,888,992.35**
Lower End of TPV Range at -35%				**$16,177,845.03**
Upper End of TPV Range at +50%				**$37,333,488.52**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-07, 1385 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-07, 1385 acres	$ 16,866,570	$ 39,142	$ 201,560	$ 17,107,272	$ 16,953,715	$ 11,019,915	$ 25,430,573
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-07, 1385 acres	$ 84,414,306	$ -	$ -	$ 84,414,306	$ 84,414,306	$ 54,869,299	$ 126,621,459
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-07, 1385 acres	$ 23,845,027	$ -	$ -	$ 23,845,027	$ 23,845,027	$ 15,499,268	$ 35,767,541

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) (1)	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs (2)	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance (3)	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report (4)	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value (5)				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

(1) Includes development of Work Plan and supporting documents, and home office support during field work.

(2) Includes lodging, airfare, and M&IE for field work.

(3) Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

(4) Includes all travel, labor, and equipment for site visit and report preparation.

(5) TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	105	hours	$150.94	$15,870.73
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	45	hours	$55.78	$2,518.24
Total Labor (Home Site) [(1)]	**588**	**hours**		**$69,026.06**
Labor Category (Field Site)				
UXO Tech I	20,101	hours	$34.96	$702,730.96
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	14,211	hours	$37.76	$536,607.36
UXO Tech II	13,589	hours	$42.29	$574,661.21
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	9,813	hours	$45.67	$448,159.71
UXO Tech III	6,744	hours	$50.69	$341,853.36
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	5,076	hours	$54.75	$277,911.00
Senior UXO Supervisor	295	hours	$63.11	$18,635.88
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	1,016	hours	$68.76	$69,860.16
UXO Safety Officer	253	hours	$59.78	$15,124.34
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	1,016	hours	$65.14	$66,182.24
UXO Quality Control Specialist	253	hours	$57.14	$14,456.42
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	1,016	hours	$62.25	$63,246.00
Total Labor (Field Site)	**203,287**	**hours**		**$8,538,299.36**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,606,291.59	$1,606,291.59
Travel Costs [(2)]	1	lump sum	$2,911,637.06	$2,911,637.06
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$6,899,528.65**
Subtotal				**$15,506,854.07**
G&A (excluding labor) @ 7.99%				$491,936.39
Subtotal (excluding fee)				**$15,998,790.46**
Fee (excluding labor & travel) @ 4.00%				$179,193.12
Fee (on labor) @ 8.00%				$688,586.03
Total Capital Costs				**$16,866,569.61**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$16,953,715.49**
Lower End of TPV Range at -35%				**$11,019,915.07**
Upper End of TPV Range at +50%				**$25,430,573.23**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	452	hours	$156.27	$70,634.04
Site Geophysicist	2,344	hours	$107.41	$251,769.04
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**3,548**	**hours**		**$417,390.20**
Labor Category (Field Site)				
UXO Tech I	101,441	hours	$34.96	$3,546,384.35
UXO Tech I (4% hazard)	12,528	hours	$36.36	$455,518.08
UXO Tech I (8% hazard)	364,661	hours	$37.76	$13,769,591.81
UXO Tech II	101,119	hours	$42.29	$4,276,314.05
UXO Tech II (4% hazard)	10,120	hours	$43.98	$445,077.60
UXO Tech II (8% hazard)	241,995	hours	$45.67	$11,051,920.78
UXO Tech III	32,188	hours	$50.69	$1,631,630.00
UXO Tech III (4% hazard)	1,680	hours	$52.72	$88,569.60
UXO Tech III (8% hazard)	121,002	hours	$54.75	$6,624,837.60
Senior UXO Supervisor	33,900	hours	$63.11	$2,139,454.24
Senior UXO Supervisor (4% hazard)	1,072	hours	$66.21	$70,977.12
Senior UXO Supervisor (8% hazard)	121,002	hours	$68.76	$8,320,070.02
UXO Safety Officer	33,872	hours	$59.78	$2,024,892.07
UXO Safety Officer (4% hazard)	1,072	hours	$62.72	$67,235.84
UXO Safety Officer (8% hazard)	121,162	hours	$65.14	$7,892,466.62
UXO Quality Control Specialist	33,872	hours	$57.14	$1,935,468.94
UXO Quality Control Specialist (4% hazard)	1,060	hours	$59.93	$63,525.80
UXO Quality Control Specialist (8% hazard)	120,994	hours	$62.25	$7,531,851.60
Total Labor (Field Site)	**1,454,740**	**hours**		**$71,935,786.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,794,797.15	$3,794,797.15
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$5,693,516.23**
Subtotal				**$78,046,692.55**
G&A (excluding labor) @ 7.99%				$405,947.71
Subtotal (excluding fee)				**$78,452,640.26**
Fee (excluding labor & travel) @ 4.00%				$173,411.88
Fee (on labor) @ 8.00%				$5,788,254.11
Total Capital Costs				**$84,414,306.24**
Alternative Net Present Value [3]				**$84,414,306.24**
Lower End of TPV Range at -35%				**$54,869,299.06**
Upper End of TPV Range at +50%				**$126,621,459.37**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	1,310	hours	$156.27	$204,713.70
Site Geophysicist	9,023	hours	$107.41	$969,138.95
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**11,057**	**hours**		**$1,264,994.09**
Labor Category (Field Site)				
UXO Tech I	32,635	hours	$34.96	$1,140,927.71
UXO Tech I (8% hazard)	61,437	hours	$37.76	$2,319,858.40
UXO Tech II	35,831	hours	$42.29	$1,515,313.63
UXO Tech II (4% hazard)	27,200	hours	$43.98	$1,196,256.00
UXO Tech II (8% hazard)	40,958	hours	$45.67	$1,870,549.67
UXO Tech III	6,800	hours	$50.69	$344,679.02
UXO Tech III (8% hazard)	20,479	hours	$54.75	$1,121,223.94
Senior UXO Supervisor	6,732	hours	$63.11	$424,840.36
Senior UXO Supervisor (4% hazard)	1,696	hours	$66.21	$112,292.16
Senior UXO Supervisor (8% hazard)	19,375	hours	$68.76	$1,332,223.35
UXO Safety Officer	7,924	hours	$59.78	$473,681.42
UXO Safety Officer (4% hazard)	1,696	hours	$62.72	$106,373.12
UXO Safety Officer (8% hazard)	19,375	hours	$65.14	$1,262,085.94
UXO Quality Control Specialist	7,904	hours	$57.14	$451,619.93
UXO Quality Control Specialist (4% hazard)	1,696	hours	$59.93	$101,641.28
UXO Quality Control Specialist (8% hazard)	19,375	hours	$62.25	$1,206,092.26
Total Labor (Field Site)	**311,112**	**hours**		**$14,979,658.18**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,778,238.10	$3,778,238.10
Travel Costs [2]	1	lump sum	$1,619,222.65	$1,619,222.65
Subcontractor Costs	1	lump sum	$315,917.25	$315,917.25
Total				**$5,713,378.00**
Subtotal				**$21,958,030.27**
G&A (excluding labor) @ 7.99%				$407,363.85
Subtotal (excluding fee)				**$22,365,394.12**
Fee (excluding labor & travel) @ 4.00%				$180,060.77
Fee (on labor) @ 8.00%				$1,299,572.18
Total Capital Costs				**$23,845,027.07**
Alternative Net Present Value [3]				**$23,845,027.07**
Lower End of TPV Range at -35%				**$15,499,267.60**
Upper End of TPV Range at +50%				**$35,767,540.61**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

	Alternative	Proposed MRS to which Alternative is Applicable	Capital Cost	Annual Operation and Maintenance Cost	Periodic Cost	Non-Discounted Constant Dollar Cost [1]	TPV at 7% Discount Rate [2]	Lower End of TPV Range at -35%	Upper End of TPV Range at +50%
1	No Action	All MRSs	$ -	$ -	$ -	$ -	$ -	$ -	$ -
2	LUCs	MRS-08, 1179 acres	$ 131,339	$ 48,224	$ 201,560	$ 381,123	$ 221,900	$ 144,235	$ 332,850
3	Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs	MRS-08, 1179 acres	$ 16,460,922	$ 39,142	$ 201,560	$ 16,701,624	$ 16,548,068	$ 10,756,244	$ 24,822,102
4	Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)	MRS-08, 1179 acres	$ 72,192,851	$ -	$ -	$ 72,192,851	$ 72,192,851	$ 46,925,353	$ 108,289,277
5	Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)	MRS-08, 1179 acres	$ 20,368,555	$ -	$ -	$ 20,368,555	$ 20,368,555	$ 13,239,560	$ 30,552,832

[1] Non-discounted constant dollar cost provided to show impact of discount rate on TPV.

[2] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7% per USEPA guidance was used to estimate TPV.

Alternative 2: LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	53	hours	$ 150.94	$ 7,999.82
Scientist I	16	hours	$ 75.23	$ 1,203.68
Scientist II	8	hours	$ 93.76	$ 750.08
Geographic Information Systems Manager	60	hours	$ 101.55	$ 6,093.00
Administrative (Home Office)	20	hours	$ 55.78	$ 1,115.60
Total Labor (Home Site) [1]	**157**	**hours**		**$ 17,162.18**
Labor Category (Field Site)				
UXO Tech II	132	hours	$ 42.29	$ 5,582.28
UXO Tech II (4% hazard)	672	hours	$ 43.98	$ 29,554.56
Senior UXO Supervisor	84	hours	$ 63.11	$ 5,301.24
Senior UXO Supervisor (4% hazard)	224	hours	$ 66.21	$ 14,831.04
Total Labor (Field Site)	**1,112**	**hours**		**$ 55,269.12**
Other Direct Costs (field equipment / rentals)	1	lump sum	$ 21,192.51	$ 21,192.51
Travel Costs [2]	1	lump sum	$ 14,686.58	$ 14,686.58
Subcontractor Costs	1	lump sum	$ 12,320.00	$ 12,320.00
Total				**$ 48,199.09**
Subtotal				**$ 120,630.39**
G&A (excluding labor) @ 7.99%				$ 3,436.60
Subtotal (excluding fee)				**$ 124,066.99**
Fee (excluding labor & travel) @ 4.00%				$ 1,477.96
Fee (on labor) @ 8.00%				$ 5,794.50
Total Capital Costs (YR 2015)				**$ 131,339.45**

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,461.32	$ 43,839.60
Subtotal				**$ 43,839.60**
Annual Cost Contingency @ 10% of Annual Costs				$ 4,383.96
Total Annual Costs (Years 1-30)				**$ 48,223.56**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$ 18,133.58**

LTM Costs (30 Years)	Quantity	Unit	Unit Price	Total
5-Year Review Report [4]	6	each	$ 33,593.35	$ 201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$ 201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$ 72,427.26**
Alternative Total Present Value [5]				**$ 221,900.30**
Lower End of TPV Range at -35%				**$144,235.19**
Upper End of TPV Range at +50%				**$332,850.44**

[1] Includes development of Work Plan and supporting documents, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes per year annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of the total 50 signs per year at $56 per sign; Labor: 2 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	102	hours	$150.94	$15,396.00
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	42	hours	$55.78	$2,342.80
Total Labor (Home Site) [(1)]	**582**	**hours**		**$68,375.89**
Labor Category (Field Site)				
UXO Tech I	19,573	hours	$34.96	$684,272.08
UXO Tech I (4% hazard)	64,848	hours	$36.36	$2,357,873.28
UXO Tech I (8% hazard)	12,097	hours	$37.76	$456,782.72
UXO Tech II	13,218	hours	$42.29	$558,989.36
UXO Tech II (4% hazard)	43,392	hours	$43.98	$1,908,380.16
UXO Tech II (8% hazard)	8,354	hours	$45.67	$381,527.18
UXO Tech III	6,562	hours	$50.69	$332,627.78
UXO Tech III (4% hazard)	21,616	hours	$52.72	$1,139,595.52
UXO Tech III (8% hazard)	4,322	hours	$54.75	$236,629.50
Senior UXO Supervisor	258	hours	$63.11	$16,282.48
Senior UXO Supervisor (4% hazard)	16	hours	$66.21	$1,059.36
Senior UXO Supervisor (8% hazard)	866	hours	$68.76	$59,546.16
UXO Safety Officer	222	hours	$59.78	$13,271.16
UXO Safety Officer (4% hazard)	16	hours	$62.72	$1,003.52
UXO Safety Officer (8% hazard)	866	hours	$65.14	$56,411.24
UXO Quality Control Specialist	222	hours	$57.14	$12,685.08
UXO Quality Control Specialist (4% hazard)	16	hours	$59.93	$958.88
UXO Quality Control Specialist (8% hazard)	866	hours	$62.25	$53,908.50
Total Labor (Field Site)	**197,330**	**hours**		**$8,271,803.96**
Other Direct Costs (field equipment / rentals)	1	lump sum	$1,575,711.98	$1,575,711.98
Travel Costs [(2)]	1	lump sum	$2,834,310.86	$2,834,310.86
Subcontractor Costs	1	lump sum	$2,381,600.00	$2,381,600.00
Total				**$6,791,622.84**
Subtotal				**$15,131,802.68**
G&A (excluding labor) @ 7.99%				$484,242.71
Subtotal (excluding fee)				**$15,616,045.39**
Fee (excluding labor & travel) @ 4.00%				$177,662.19
Fee (on labor) @ 8.00%				$667,214.39
Total Capital Costs				**$16,460,921.97**

Alternative 3: Surface Clearance of MEC with Analog Detection Methods, and LUCs

Annual Costs (30 years)	Quantity	Unit	Unit Price	Total
Sign Maintenance [3]	30	years	$ 1,186.12	$35,583.60
Subtotal				**$35,583.60**
Annual Cost Contingency @ 10% of Annual Costs				$3,558.36
Total Annual Costs (Years 1-30)				**$39,141.96**
PV of Annual Costs Over 30 Years (7% Discount Rate)				**$14,718.61**
LTM Costs (30 Years)	**Quantity**	**Unit**	**Unit Price**	**Total**
5-Year Recurring Review Report [4]	6	each	$33,593.35	$201,560.10
Total LTM Costs (Years 5, 10, 15, 20, 25, 30)				**$201,560.10**
PV of 6 Recurring Review Reports (Years 5, 10, 15, 20, 25, 30) (7% Discount Rate)				**$72,427.26**
Alternative Net Present Value [5]				**$16,548,067.84**
Lower End of TPV Range at -35%				**$10,756,244.10**
Upper End of TPV Range at +50%				**$24,822,101.76**

[1] Includes development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for field work.

[3] Assumes annual replacement of damaged and/or vandalized signs (Equipment: assumes 10% replacement of total 34 signs per year at $56 per sign; Labor: 1 hour per sign at a rate of $58 per hour). (Annual travel costs of $601.32 are included).

[4] Includes all travel, labor, and equipment for site visit and report preparation.

[5] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 4: UU/UE Surface Clearance and Subsurface Removal of MEC to Depth of Detection with DGM Detection Methods (UU/UE Method A)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	282	hours	$150.94	$42,565.08
Senior Geophysicist	392	hours	$156.27	$61,257.84
Site Geophysicist	1,994	hours	$107.41	$214,175.54
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Administrative (Home Office)	32	hours	$55.78	$1,784.96
Total Labor (Home Site) [1]	**3,138**	**hours**		**$370,420.50**
Labor Category (Field Site)				
UXO Tech I	86,334	hours	$34.96	$3,018,239.44
UXO Tech I (4% hazard)	10,568	hours	$36.36	$384,252.48
UXO Tech I (8% hazard)	310,336	hours	$37.76	$11,718,299.44
UXO Tech II	86,213	hours	$42.29	$3,645,935.93
UXO Tech II (4% hazard)	8,608	hours	$43.98	$378,579.84
UXO Tech II (8% hazard)	206,003	hours	$45.67	$9,408,151.53
UXO Tech III	27,409	hours	$50.69	$1,389,380.46
UXO Tech III (4% hazard)	1,400	hours	$52.72	$73,808.00
UXO Tech III (8% hazard)	103,005	hours	$54.75	$5,639,547.84
Senior UXO Supervisor	28,871	hours	$63.11	$1,822,071.53
Senior UXO Supervisor (4% hazard)	912	hours	$66.21	$60,383.52
Senior UXO Supervisor (8% hazard)	103,005	hours	$68.76	$7,082,654.05
UXO Safety Officer	28,843	hours	$59.78	$1,724,256.06
UXO Safety Officer (4% hazard)	912	hours	$62.72	$57,200.64
UXO Safety Officer (8% hazard)	103,165	hours	$65.14	$6,720,196.76
UXO Quality Control Specialist	28,843	hours	$57.14	$1,648,109.59
UXO Quality Control Specialist (4% hazard)	900	hours	$59.93	$53,937.00
UXO Quality Control Specialist (8% hazard)	102,997	hours	$62.25	$6,411,590.64
Total Labor (Field Site)	**1,238,327**	**hours**		**$61,236,594.75**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,242,268.51	$3,242,268.51
Travel Costs [2]	1	lump sum	$1,764,166.89	$1,764,166.89
Subcontractor Costs	1	lump sum	$134,552.19	$134,552.19
Total				**$5,140,987.59**
Subtotal				**$66,748,002.84**
G&A (excluding labor) @ 7.99%				$366,552.41
Subtotal (excluding fee)				**$67,114,555.25**
Fee (excluding labor & travel) @ 4.00%				$149,734.92
Fee (on labor) @ 8.00%				$4,928,561.22
Total Capital Costs				**$72,192,851.40**
Alternative Net Present Value [3]				**$72,192,851.40**
Lower End of TPV Range at -35%				**$46,925,353.41**
Upper End of TPV Range at +50%				**$108,289,277.10**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP

[2] Includes lodging, airfare, and M&IE for field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. Discount rate of 7 percent per USEPA guidance was used to estimate TPV.

Alternative 5: UU/UE - Surface Clearance and Subsurface Removal of MEC to Depth of Detection with Advanced Classification Methods (UU/UE Method B)

Field Work Costs	Quantity	Unit	Unit Price	Total
Labor Category (Home Site)				
Project Manager	258	hours	$150.94	$38,942.52
Senior Geophysicist	1,112	hours	$156.27	$173,772.24
Site Geophysicist	7,652	hours	$107.41	$821,901.32
Scientist II	78	hours	$93.76	$7,313.28
Scientist III	120	hours	$133.13	$15,975.60
Engineer I	40	hours	$77.15	$3,086.00
Geographic Information Systems Manager	60	hours	$101.55	$6,093.00
Risk Assessor	140	hours	$129.78	$18,169.20
Administrative (Home Office)	28	hours	$55.78	$1,561.84
Total Labor (Home Site) [1]	**9,488**	**hours**		**$1,086,815.00**
Labor Category (Field Site)				
UXO Tech I	27,760	hours	$34.96	$970,478.86
UXO Tech I (8% hazard)	52,295	hours	$37.76	$1,974,650.56
UXO Tech II	30,528	hours	$42.29	$1,291,020.46
UXO Tech II (4% hazard)	23,280	hours	$43.98	$1,023,854.40
UXO Tech II (8% hazard)	34,863	hours	$45.67	$1,592,201.47
UXO Tech III	5,828	hours	$50.69	$295,416.13
UXO Tech III (8% hazard)	17,432	hours	$54.75	$954,379.57
Senior UXO Supervisor	5,762	hours	$63.11	$363,633.36
Senior UXO Supervisor (4% hazard)	1,456	hours	$66.21	$96,401.76
Senior UXO Supervisor (8% hazard)	16,496	hours	$68.76	$1,134,236.80
UXO Safety Officer	6,744	hours	$59.78	$403,150.20
UXO Safety Officer (4% hazard)	1,456	hours	$62.72	$91,320.32
UXO Safety Officer (8% hazard)	16,496	hours	$65.14	$1,074,522.76
UXO Quality Control Specialist	6,724	hours	$57.14	$384,203.51
UXO Quality Control Specialist (4% hazard)	1,456	hours	$59.93	$87,258.08
UXO Quality Control Specialist (8% hazard)	16,496	hours	$62.25	$1,026,850.50
Total Labor (Field Site)	**265,069**	**hours**		**$12,763,578.73**
Other Direct Costs (field equipment / rentals)	1	lump sum	$3,239,293.06	$3,239,293.06
Travel Costs [2]	1	lump sum	$1,393,675.09	$1,393,675.09
Subcontractor Costs	1	lump sum	$272,894.15	$272,894.15
Total				**$4,905,862.30**
Subtotal				**$18,756,256.03**
G&A (excluding labor) @ 7.99%				$349,787.98
Subtotal (excluding fee)				**$19,106,044.01**
Fee (excluding labor & travel) @ 4.00%				$154,479.01
Fee (on labor) @ 8.00%				$1,108,031.50
Total Capital Costs				**$20,368,554.52**
Alternative Net Present Value [3]				**$20,368,554.52**
Lower End of TPV Range at -35%				**$13,239,560.44**
Upper End of TPV Range at +50%				**$30,552,831.78**

[1] Includes TPP Meetings, development of Work Plan (including PMP, QASP, and UFP-QAPP), GIS deliverables, ROEs, SSFR, and CRP Addendum, and home office support during field work.

[2] Includes lodging, airfare, and M&IE for TPP Meetings and field work.

[3] TPV estimates are considered accurate to within -30 percent and +50 percent of actual costs. No periodic or annual O&M costs associated with Alternative 6.

APPENDIX A

REMEDIAL ACTION ALTERNATIVE COST CALCULATIONS

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