Corrective Measures Study
Environmental Restoration Services at Anti-Tank Range 90-MM-2 (FTSW-010-R-01) United States Army Garrison - Fort Stewart

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Acronyms

Acronym	Definition
AP	Armor Piercing
APP	Accident Prevention Plan
AT	Anti-Tank
bgs	Below Ground Surface
CAP	Corrective Action Plan
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Code of Federal Regulations
CHE	Chemical Warfare Material Hazard Evaluation
CMIP	Corrective Measures Implementation Plan
CMS	Corrective Measures Study
CS	Confirmatory Sampling
CWM	Chemical Warfare Material
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DMM	Discarded Military Munitions
DoD	Department of Defense
EHE	Explosive Hazard Evaluation
EPA	Environmental Protection Agency
ESS	Explosives Safety Submission
ESV	Ecological Screening Value
ft	Feet
FTSW	Fort Stewart
GAEPD	Georgia Environmental Protection Division
HA	Hazard Assessment
HHE	Health Hazard Evaluation
LUC	Land Use Control
LUCIP	LUC Implementation Plan
MC	Munitions Constituents
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MRS	Munitions Response Site
msl	Mean Sea Level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NFA	No Further Action
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RSL	Regional Screening Level
RTC	Response to Comment
SB	Statement of Basis
SUXOS	Senior Unexploded Ordnance Supervisor
TMV	Toxicity, Mobility, or Volume (of Waste)
TNT	Trinitrotoluene
TP	Target Practice
USACE	United States Army Corps of Engineers
USAEC	US Army Environmental Command
USAG	United States Army Garrison

Acronym	Definition
USEPA	U.S. Environmental Protection Agency
USGS	United States Geological Survey
UXO	Unexploded Ordnance
UXOSO	Unexploded Ordnance Safety Officer
UXOQCS	Unexploded Ordnance Quality Control Specialist
VSP	Visual Sample Plan

EXECUTIVE SUMMARY

This report presents a Corrective Measures Study (CMS) in the form of a Corrective Action Plan (CAP) for the Munitions Response Site (MRS) Fort Stewart (FTSW)-010-R-01: Anti-Tank Range 90-MM-2, hereafter referred to as the Site, at Fort Stewart, Georgia. This report is prepared on behalf of the US Army Environmental Command (USAEC) in accordance with Task Order W9124J-19-F-00A4 of Contract No. W9124J-18-D-0008 and FTSW's Resource Conservation and Recovery Act (RCRA) Part B Permit No. HW-045(S)-4, as issued by the Georgia Environmental Protection Division (GAEPD) on August 15, 2017.

The purpose of this document is to outline corrective measures required to address the presence or potential presence of munitions and explosives of concern (MEC) at the Site, and to define the risk-reduction objectives for the corrective measures. This document will evaluate a range of actions/alternatives to minimize or eliminate potential risks associated with MEC and, based on this evaluation, select appropriate remedies. A conceptual design, schedule, and cost estimate will also be provided.

FTSW comprises approximately 280,000 acres and the Garrison Area is located adjacent to Hinesville, Georgia (GA), approximately 40 miles southwest of Savannah, Georgia (Figure 1). FTSW is the largest US Army installation east of the Mississippi River and covers portions of Bryan, Evans, Liberty, Long, and Tattnall counties. Georgia State Highways 119 and 144 bisect the installation. Anti-Tank Range 90-MM-2 (AT 90-MM-2) is in the northwestern part of the cantonment area, which is the southernmost portion of Fort Stewart.

The Site is approximately 546 acres and encompasses the former firing points for 40-mm anti-aircraft and 90-mm anti-tank training ranges, operational during the 1940s. Historical documentation indicates the firing area was previously located where a motor pool and vehicle fueling station are located now. The range fans extend past the currently defined MRS. A separate MRS, Anti-Tank Range 90-MM (FTSW-003-R-01), is currently a RCRA Permitted landfill that is located immediately adjacent to and partially surrounded by AT 90-MM-2. These were historically part of the same Anti-Tank Range. The landfill was granted a no further action (NFA) under the Military Munitions Response Program (MMRP), and it continues to be monitored and managed as a landfill under the RCRA program. AT 90-MM-2 excludes the landfill. The western portion of the Site partially overlaps former grenade launcher, small arms, and 120 mm anti-aircraft range fans that fired from south of this MRS.

Throughout the course of previous studies, various munitions debris (MD) was discovered at the Site, and one item, a 25-mm target practice (TP) projectile (with cartridge intact), was recovered on the ground surface and classified at the time as material potentially presenting an explosive hazard (MPPEH). After further review, this item is considered MEC for the purpose of this study. The projectile appeared to be post-1970's vintage and more recent than the historical use of the range. The pathway to MEC at the ground surface is considered complete. No MEC has been discovered in the subsurface and the pathway to MEC in the subsurface is considered incomplete.

Previously conducted soil sampling suggests there is no observed MC hazard associated with the Site (Arcadis/Malcolm Pirnie, 2011; CB&I, 2018).

Based on previous investigations, MEC is present on the ground surface at the site. Use of the site includes training maneuvers, recreation (e.g. bow hunting), a borrow pit, and industrial areas including laydown yards, a motor pool, a motor fuel and wash yard, and Pond #10. Therefore, a corrective measure is needed to mitigate unacceptable risk. The Corrective Measures Study Objectives are to:

- mitigate the human exposure to potential subsurface MEC, such that an acceptable scenario is determined to be present.

To recommend alternatives that will effectively address the corrective measures objectives described above, each alternative is screened and evaluated based on the following balancing criteria:

1. Long-term Effectiveness;
2. Reduction in the Toxicity, Mobility, or Volume of Wastes ;
3. Short-term Effectiveness;
4. Implementability;
5. Community Acceptance;
6. State Acceptance; and
7. Cost Estimate.

Three alternatives are considered in this study: No Action, Land Use Controls (LUCs), and MEC Surface Clearance. Based on the balance of the five aforementioned criteria, the Surface Clearance is selected as the recommended remedy at the Site.

This alternative is preferred because the Site is developed for long-term industrial and recreational land use with the installation of operational buildings and allowance for hunting on the MRS. Removal of remaining MEC at the surface would remove the potential for humans to encounter MEC at the Site and provides a path forward while minimizing land-use restrictions.

The surface clearance would include a complete surface sweep of the MRS, consisting of a magnetometer-assisted visual survey and removal action of the areas of the Site that have not been previously investigated. The preferred alternative also includes provision of MEC awareness training for personnel involved in removal of material at the borrow pit located in the MRS, to prevent contact with potential unforeseen MEC hazards associated with continued excavation into the subsurface.

Implementation of the surface removal action will remove MEC present at the surface, rendering the pathway to MEC incomplete. The preferred alternative carries the additional benefit of not requiring long-term maintenance effort or cost while minimizing the extent of land-use restrictions. An institutional control requiring approval for intrusive activities at the MRS will also be implemented given the historical use of the range.

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1 INTRODUCTION

This report presents a Corrective Measures Study (CMS) in the form of a Corrective Action Plan (CAP) for the Munitions Response Site (MRS) Fort Stewart (FTSW)-010-R-01: Anti-Tank Range 90-MM-2 (AT 90-MM-2), hereafter referred to as the Site, at Fort Stewart, Georgia. This report is prepared on behalf of the US Army Environmental Command (USAEC) in accordance with Task Order W9124J-19-F-00A4 of Contract No. W9124J-18-D-0008 and FTSW's Resource Conservation and Recovery Act (RCRA) Part B Permit No. HW-045(S)-4, as issued by the Georgia Environmental Protection Division (GAEPD) on August 15, 2017.

The U.S. Department of Defense (DoD) established the Military Munitions Response Program (MMRP) to address DoD sites suspected to contain munitions and explosives of concern (MEC) or munitions constituents (MC). DoD policy states that these responses shall be conducted in accordance with RCRA, CERCLA, and the NCP, as applicable. This site is managed under FTSW's RCRA Part B Permit, and regulated by the GA EPD.

1.1 Purpose

The purpose of this document is to outline corrective measures required to address the presence or potential presence of MEC at the Site. This document will evaluate a range of actions/alternatives to minimize or eliminate potential risks associated with MEC and, based on this evaluation, select appropriate remedies. A conceptual design, schedule, and cost estimate will also be provided.

1.2 Report Organization

Section 1: Introduction

Section 2: Site Characterization and Investigation Results

Section 3: Conceptual Site Model

Section 4: Corrective Measures Objectives and Corrective Action Alternatives

Section 5: Selection of Preferred Alternative

Section 6: References

2 SITE CHARACTERIZATION AND INVESTIGATION RESULTS

2.1 Site Location

FTSW comprises approximately 280,000 acres and the Garrison Area is located adjacent to Hinesville, Georgia (GA), approximately 40 miles southwest of Savannah, Georgia (Figure 1). FTSW is the largest US Army installation east of the Mississippi River and covers portions of Bryan, Evans, Liberty, Long, and Tattnall counties. Georgia State Highways 119 and 144 bisect the installation. The Site is in the northwestern part of the cantonment area, which is the southernmost portion of Fort Stewart. A map of the Site is provided in Figure 2.

2.2 Site Description and History

Prior to 1940, FTSW was the Camp Savannah Aircraft Firing Center. The installation was designated Camp Stewart in 1940 in preparation for World War II. The camp supported artillery troop anti-aircraft training, armor and tank training, GA National Guard training, and served as a separation center for redeployed troops. In 1956, Camp Stewart became Fort Stewart, a permanent Army Installation. In 1966, an element of the U.S. Army Aviation School at Fort Rucker, Alabama, was transferred to Fort Stewart, and the focus of FTSW became fixed-wing and helicopter training and gunnery training for the Vietnam War. FTSW is now home to the Third Infantry Division (Mechanized); its current mission is to maintain quality of life, readiness, and provide support for training missions.

The Site is approximately 546 acres and encompasses the former firing points for 40-mm anti-aircraft and 90-mm anti-tank training ranges, operational during the 1940s. Historical documentation indicates the firing area was previously located where a motor pool and vehicle fueling station are located now. The range fans extended past the currently defined MRS and into the greater operational area of FTSW. Aerial photographs from the 1940s show two ground scars, approximately 1,500 feet apart, that are likely the 40-mm and 90-mm firing positions. The current location of a landfill was formerly occupied by a figure-eight track that was part of a mounted target system for anti-aircraft training. Armor piercing (AP) projectiles used at the range were steel projectiles that could have been filled with trinitrotoluene (TNT) or Comp B (TNT/Research Department Formula X [RDX]), according to technical data sheets. Use of other munitions at the range is not recorded in available historical documents (CB&I, 2018).

The western portion of the Site partially overlaps historical grenade launcher, small arms, and 120 mm anti-aircraft range fans that fired from former locations south of the MRS.

The Site partially surrounds a separate MRS, a RCRA Permitted landfill, Anti-Tank Range 90-MM (FTSW-003-R-01). These were historically one MRS, with the target impact area of the Former Anti-Tank 90-MM Range (FTSW-003-R-01) located where the landfill is now. The landfill area operates under an operating permit monitored by RCRA, and the Confirmatory Sampling Report (Malcom Pirnie, 2007) recommended the landfill portion of FTSW-003-R-01 receive NFA, since it is an active landfill. The remainder of FTSW-003-R-01 was recommended to be included with FTSW-10-R-01 and approved by GA EPD on 3/3/2008. AT 90-MM-2, as discussed in this report, excludes the landfill area, accordingly.

2.3 Environmental Setting

2.3.1 Topography and Physiography

The land beneath FTSW is primarily flat-lying, with surface elevations across most of the installation ranging from approximately 2 to 30 meters above mean sea level (msl). The northwestern portion of FTSW features gently rolling hills with elevations ranging from 30 to 55 meters above msl (Arcadis/Malcolm Pirnie, 2011) (Figure 3).

The climate at FTSW is classified as humid subtropical, characterized by well-defined seasons with hot, humid summers and mild winters. The National Oceanic and Atmospheric Administration reports the average annual precipitation for Fort Stewart, GA, as 50 inches (NOAA, 2019).

2.3.2 Land Use and Natural Resources

FTSW includes four main types of ecosystems: sand hills, pine flatwoods, upland forests, and wetlands. Just over half of the installation comprises upland forests, which provide habitat to various plants and animals, including game hunted for recreation and human consumption. Roughly a third of the installation is covered by wetlands, including black water swamps, cypress-gum swamps, stream head pocosins, bay forests, and wet pine flatwoods. Approximately 15 percent of the installation is cleared and/or developed land (CB&I, 2018). Except for the habitats provided by forested areas, there are no known site-specific, sensitive ecological or cultural resources at this MRS (Arcadis/Malcolm Pirnie, 2011).

Surface waters at FTSW include various aquatic habitats that provide fish and crustaceans for human consumption, wetlands, and water recreational areas. Surface water features include the Canoochee River, Canoochee Creek and its tributaries, both man-made and natural ponds and lakes, and numerous bottomland swamps and pools.

Land at the Site is largely undeveloped forested land. Bow hunting is permitted at the Site, and training maneuvers are conducted in the area. The Site also contains a fenced motor pool, laydown yards, a borrow pit, a motor fuel and wash yard, and Pond #10. No changes in land use are currently anticipated or planned (URS and Arcadis/Malcom Pirnie, 2013; CB&I, 2018).

2.4 Geology

FTSW is located within the Southern Coastal Plain physiographic province. The province comprises a wedge of gently southeast dipping clastic sediments, primarily sand, silt, and clay, overlying crystalline metamorphic basement rock. The unconsolidated sediment wedge thickens to the east, reaching a maximum thickness of approximately 2,300 meters. The metamorphic basement complex underlying the sediment wedge ranges from Precambrian to Triassic in age, and dips coastward at about 5.7 meters per kilometer from the Fall Line, near Macon and Augusta, GA, to the Savannah, GA area. (Arcadis/Malcolm Pirnie, 2011).

Soils at FTSW are commonly Ellabelle loamy sand, Ogeechee, Pelham, Stilson, Rutlege, Leefield, and Mascotte. Soils identified on FTSW are described as being poorly-drained. The majority of the soils observed include a sandy surface layer overlying subsurface soil that may consist of sand, clay, loam, or a combination of these. Generally, the surface soils lack cohesive clays and can be prone to erosion, however soils at the Site are not highly eroded, owing to relatively flat terrain and adequate vegetation (CB&I, 2018).

2.5 Hydrogeology

Coastal Plain strata underly FTSW, including three major aquifer systems. From surface to depth, these are the surficial aquifer system, the Brunswick aquifer system, and the Floridan aquifer system.

The surficial aquifer system comprises interlayered sand, clay, and thin beds of limestone. At FTSW, the surficial aquifer includes an unconfined zone ranging from 20-40 feet (ft) below ground surface (bgs) and a deeper, confined zone ranging from 50 – 90 ft bgs. A confining layer of silty clay and dense phosphatic limestone separates the surficial system from the deeper Brunswick aquifer system.

The Brunswick aquifer system comprises upper and lower water-bearing zones of sand and limestone separated by an approximately 70 ft thick confining layer of clay and sand. A confining unit of silty clay and dense phosphatic dolomite separate the Brunswick aquifer system from the deeper Floridan aquifer system.

The Floridan aquifer system comprises relatively permeable carbonate rocks in several water-bearing zones separated by layers of dense, relatively impermeable limestone that act as semi-confining layers. With 20 wells completed in the Floridan system (ranging from 500-800 ft, cased to 400-470 ft), the Floridan aquifer system is the primary source of potable water at FTSW (USGS, 2011; CB&I, 2018).

2.6 Historical Investigations and Remedial Actions

Historical investigations and remedial actions spanning 2010 through 2018 are summarized in the below subsections.

2.6.1 Confirmatory Sampling (CS)

Confirmatory sampling (CS) was performed in August 2010 (Arcadis/Malcolm Pirnie, 2011). The investigation included a magnetometer-assisted visual survey over 10 percent, approximately 33 acres, of the undeveloped areas of the MRS. A practice M16A1 anti-personnel mine (inert) was identified and classified as munitions debris (MD).

To assess potential presence of MC, four discrete soil samples were collected from the Site. Two of the samples were biased toward suspected former firing lines, and two were randomly distributed across the survey area. The samples were collected from the top 6 inches of soil sand analyzed for aluminum, antimony, copper, lead, and zinc by USEPA Method 6010B, and for explosives by Method 8330B Modified. These analytes were targeted based on the types of munitions known to have been used at the MRS.

No explosives were detected in any of the samples. No metals were detected in excess of their USEPA RSLs. Zinc was detected above the ESV and above the FTSW Background Value in one sample; however, the detected zinc concentration is within an order of magnitude of the Background Value and is considered more likely to be naturally occurring than associated with historical munitions use at the Site (Arcadis/Malcolm Pirnie, 2011).

2.6.2 RCRA Facility Investigation (RFI)

A RCRA Facility Investigation (RFI) was conducted at the Site in September to December of 2015, and the final report was approved in March 2018 (CB&I, 2018). The purpose of the RFI was to identify and characterize the nature and extent of MEC hazards and risk to potential receptors at the Site. Potential sources of MEC were expected to include 40-mm anti-aircraft munitions, 90-mm anti-tank munitions, and potentially 120-mm anti-aircraft projectiles that may have fallen short of their targets. Historical records reviews yielded no evidence of stationary land-based targets at the Site, so an overall homogenous MEC distribution was expected in both the surface and subsurface of the range, except for the potential for concentrated discarded military munitions (DMM) buried in the subsurface near the firing points. Historical records suggest tank targets were located underneath where the landfill is located today.

Investigations completed during the RFI included analog geophysical transects over 6.0 acres of the Site, a digital geophysical mapping (DGM) survey over 5.8 miles of transects, and an intrusive investigation of anomalies associated with the suspected firing points. An initial mag and dig investigation was performed using Schonstedt magnetometers along transects located based on analysis using Unexploded Ordnance (UXO) Estimator.

Transects for the DGM survey were preferentially placed according to analysis in UXO Estimator. DGM data channels were interpolated, processed, and color coded with Geosoft's Oasis Montaj UX Process Software. Data for each data acquisition session were regularly provided to United States Army Corps of Engineers (USACE) for independent evaluation using a secure collaborative web portal.

Anomalies with greater than one-meter footprints were considered large enough to potentially represent multiple buried items. Visual Sample Plan's (VSP) "Anomaly Sampling for UXO" module was utilized to select targets from these anomalies to investigate such that the dig results would provide 95% confidence that 95% of the remaining anomalies would not contain MEC if none of the selected anomalies contained MEC (CB&I, 2018).

The DGM investigation yielded 733 anomalies with footprints in excess of one meter. VSP analysis identified 57 target anomalies that, if found not to contain MEC, would provide the required confidence that the other anomalies would also not contain MEC. These 57 targets were reacquired and intrusively investigated. No MEC was identified at these locations (CB&I, 2018).

The items recovered in the RFI are summarized in Table 2-1. The magnetometer survey yielded 11 items classified as MD, including 40-mm TP projectiles, 90-mm APT projectiles, 2.36-inch practice rockets, a flare, and practice/training submunition. The majority of these MD were located at the surface, while four items were located in the subsurface from depths of 5 to 18 inches (90-mm APT projectiles). One item at the surface was identified as a 25-mm TP projectile (with cartridge intact) and classified as material potentially presenting an explosive hazard (MPPEH) (CB&I, 2018). The RFI noted that this MPPEH item and one MD item (25-mm TP-T cartridge) were of a more recent vintage (post-1970) than items associated with historical range operations. The DGM survey yielded two items, classified as MD, a 40-mm TP projectile and a mortar of unknown type. These were located at depths of 6 and 12 inches, respectively. No MEC was identified in either survey, and one MPPEH item was identified on the surface (CB&I, 2018).

For the purposes of this CMS, the discarded 25-mm TP-T projectile found as a complete round and classified in the 2018 RFI as MPPEH, will be considered a MEC item. Although it is not considered associated with the historical use of the range, the presence of this MEC item at the MRS must be addressed.

Table 2-1 Summary of Items Recovered at Range 90-MM-2

Source	Item Recovered	Quantity	Classification	Depth
Confirmation Sampling (Arcadis/Malcolm Pirnie, 2011)	Practice M16A1 Anti-Personnel Mine	1	MD	Surface
RFI- Mag and Dig Transects (CB&I, 2018)	2.36-inch practice rockets	2	MD	Surface
	40-mm TP projectiles	2	MD	Surface
	40-mm TP projectiles	1	MD	6"
	90-mm APT projectiles	3	MD	5", 12", 18"
	Flare	1	MD	Surface
	25-mm TP-T cartridge *	1	MD	Surface
	25-mm TP projectile *	1	MPPEH/MEC	Surface
	Practice/Training submunition	1	MD	Surface
RFI- DGM Grids (CB&I, 2018)	40-mm TP Projectile	1	MD	6"
	Mortar (unknown type)	1	MD	12"

*Not associated with historical range activities (post-1970 vintage)

According to the approved work plan for the RFI, the absence of any identified material containing explosives deemed additional environmental sampling for MC unnecessary.

Based on the model used in the RFI, because 57 out of 57 of the selected target anomalies did not contain MEC, the RFI stated with 95 percent confidence that 95 percent of the 733 identified anomalies near the firing points also do not contain MEC (CB&I, 2018). It should be noted that two of the 57 anomalies were identified as MD; an expended 40 mm practice projectile at six inches bgs and an inert mortar at 12 inches bgs.

A MEC Hazard Analysis was not completed in the RFI because the RFI reported no MEC in the MRS (CB&I, 2018). MD consistent with historical records of range use were observed on the surface and subsurface. As there was no stated source of MEC at the Site, the pathway for exposure to MEC was considered incomplete in the RFI (CB&I, 2018). MPPEH in the form of a discarded 25-mm TP-T projectile on the ground surface was discovered and represented an MPPEH source. Accordingly, the MPPEH exposure pathway was considered complete at the surface, and incomplete in the subsurface (CB&I, 2018). This CMS considers the MPPEH item to be MEC. With ongoing use of the MRS, the MEC exposure pathway is complete at the ground surface.

3 CONCEPTUAL SITE MODEL

3.1 Source

Section 2.6.6 describes the source of MEC investigated during the 2018 RFI. In this model, the source contamination consists of MEC discovered at the ground surface.

3.2 Interaction

The MEC discovered during investigations at the Site were discovered at the surface. The MRS is partially developed and maintained. There is a potential for receptors walking in the area to interact with MEC possibly present at the surface.

Hazards from MEC derive from direct contact. Human contact that may disturb MEC at the surface can occur by simply walking around or through MEC affected areas.

3.3 Receptors

Anti-Tank 90-MM-2 is largely undeveloped forested land. Facilities at the MRS include a laydown yard, a fenced motor pool, a motor fuel and wash yard, Pond #10, and a borrow pit. Bow hunting is permitted at the MRS. Receptors include:

- Indoor Facility Workers who occupy FTSW buildings for work purposes;
- Maintenance and Construction Workers who may perform landscaping, grounds keeping, or excavation activities, especially at the on-site borrow pit; and
- Visitors and recreators who may access the area, including those partaking in bow hunting activities at the MRS.

All of these potential receptors are expected to walk around or through the MRS, primarily on sidewalks, roads, and green spaces. Interaction with MEC present on the ground surface could occur during these activities. The MEC item discovered during the RFI was located on the ground surface in a wooded area approximately 300 feet west of the fueling area and approximately 0.35 miles east-northeast of the borrow pit area.

4 CORRECTIVE MEASURES OBJECTIVES AND CORRECTIVE ACTION ALTERNATIVES

4.1 Establishment of Corrective Measures Objectives

Based on previous investigation, MEC is present at this Site. As discussed in Section 3.1 through 3.3, there exists a risk of interaction between human receptors and MEC at the ground surface. Therefore, a corrective measure is required to mitigate unacceptable risk. For this Site, the corrective measures objectives are to:

- mitigate the human exposure to potential subsurface MEC, such that acceptable risk is determined to be present.

Based on results of the RFI, the analysis of existing data used to evaluate the extent of MEC and exposure pathways to MEC on the surface, a CMS is required to address MEC on the surface pursuant to the corrective measures objectives.

4.2 Establishment of Corrective Action Alternatives

Corrective measures technologies are being considered for the Site to ensure the protection of current and future receptors from hazards associated with MEC. The choices for technologies for any given site are dependent upon characteristics of the site, costs, access restrictions, as well as future land use and exposure scenarios.

To recommend alternatives that will effectively address the corrective measures objectives described above, each alternative will be screened and evaluated based on the following balancing criteria:

1. Long term effectiveness
2. Reduction in the Toxicity, Mobility, or Volume (TMV) of Wastes
3. Short-term effectiveness
4. Implementability
5. Community Acceptance
6. State Acceptance
7. Cost estimate

Such a recommendation shall include a description and supporting rationale for the proposed remedy, including how it will achieve the clean-up objectives and the proposed remedy's relationship to the balancing criteria.

In accordance with the RCRA permit for Fort Stewart and utilizing United States Environmental Protection Agency (USEPA) Guidance on RCRA Corrective Action Decisions Documents (EPA/540/G-91/011; USEPA, 1991), all alternatives will require the preparation of a Statement of Basis (SB) document. The SB will undergo a Public Comment Period followed by the preparation of a response to comment (RTC) document. Additional aspects of the individual corrective measures alternatives are detailed in the following sections.

Three alternatives were selected for evaluation for the Site:

1. No Action
2. Land Use Controls
3. MEC Surface Clearance

In the following subsections, these three alternatives are evaluated using the balancing criteria. A summary of the balancing criteria evaluation is presented in Table 4-1.

Table 4-1 Summary of Balancing Criteria

Alternatives	Long-Term Effectiveness	Reduces TMV	Short-Term Effectiveness	Implementability	Cost Estimate
No Action	Ineffective	Ineffective	Ineffective	High Ease	$18,144
Land Use Controls	Moderately Effective	Moderately Effective	Effective	Moderate Ease	$635,582
MEC Surface Clearance	Effective	Effective	Effective	Moderate Ease	$3,458,232

4.2.1 Alternative 1- No Action

Alternative 1 takes a "No Action" approach as a Corrective Action Alternative. No Action does not require the use of technologies associated with a response action. This option does not include any institutional controls or any action to control, treat, remove or dispose of MEC associated with the Site. This alternative is included to provide a status quo baseline for comparison to the other alternatives. The balancing criteria for Alternative 1 are described below.

Long-term Effectiveness
Alternative 1 does not effectively address site risk for the long-term. Since the Site has been determined to have moderate explosive risk, Alternative 1 would not address the hazardous risk under analogous site conditions over an extended period of time.

Reduces TMV of Waste
Alternative 1's "No Action" approach does not reduce the volume of MEC or alter the pathway through which humans may be exposed to MEC.

Short-term Effectiveness
Alternative 1 does not effectively address site risk for the short-term. Since the Site has been determined to have moderate explosive risk and the Site currently has a population with a moderate risk of encountering MEC, Alternative 1 would not address the hazardous risk to receptors.

Implementability
Alternative 1 is highly implementable and requires no effort beyond the SB. No additional administrative activities are required, no time is required to implement, and no technologies are required to implement the alternative.

Community Acceptance
Community Acceptance of Alternative 1 is unlikely. It is improbable that the community will accept "No Action" towards mitigating potential explosive hazards.

State Acceptance
State Acceptance of Alternative 1 by is unlikely. The "No Action" approach is not sufficient in mitigating potential explosive hazards.

Cost Estimate
Alternative 1 is considered a low-cost alternative for the Site, incorporating only the cost for the SB. The estimated cost to implement this alternative is $18,144. Support for this estimate is provided in Appendix A.

Alternative 1 is not an effective approach at reducing the exposure of humans to MEC related hazards through the means of inaction. Alternative 1 is not retained for the Site.

4.2.2 Alternative 2- Land Use Controls

Land Use Controls (LUCs) include actions such as land use restrictions and access restrictions to reduce the potential exposure to MEC. LUCs include engineered and non-engineered instruments such as physical barriers preventing access to contaminated locations, as well as legal and/or administrative controls that minimize the potential for human exposure to MEC by limiting the use of land. LUCs would require monitoring of engineered and institutional controls through periodic inspections and reporting on a regular basis. As part of the institutional controls, a review is performed to determine the presence of risk due to MEC prior to initiation of any subsurface work, including excavation and construction.

LUCs at the Site would include signage with warnings pertaining to the MEC hazard and an installation contact for potential MEC encounters, institutional controls restricting unauthorized access to the area, and provision of trained personnel to support activities occurring at the borrow pit located at the Site. LUCs would meet guidelines outlined in the DoD Policy on LUCs Associated with Environmental Restoration Activities (DoD, 2001). The areas requiring signage are shown on Figure 4. Furthermore, should hunting continue at the site, hunters should be briefed on UXO awareness training consisting of the three Rs (i.e., recognize, retreat, report) prior to accessing the site.

Long Term Effectiveness
Alternative 2 is moderately effective on a long-term basis by limiting potential exposure to MEC through engineered and institutional controls, discouraging impermissible access to untrained personnel in the potentially MEC affected area.

Reduces TMV of Waste
Alternative 2 is a moderately effective approach to reducing the toxicity, mobility, or volume of MEC by potentially altering the pathway through which humans may be exposed to MEC. Institutional controls are maximized when implemented alongside engineering controls including signage. Alternative 2 is moderately effective in that it discourages, but does not physically limit, unintentional contact between human receptors and potential MEC at the ground surface.

Short-term Effectiveness
Alternative 2 is immediately effective in the short-term by reducing the likelihood of unintentional access to the surface though warnings regarding potential MEC affected areas.

Implementability
Alternative 2 is implementable with moderate ease. Administrative activities would be required to implement this corrective measure in the form of updates to the base-wide Master Plan and a Corrective Measures Implementation Plan (CMIP) in the form of a LUC Implementation Plan (LUCIP). Construction of Alternative 2 requires the installation of up to 334 numbered, post-mounted signs no greater than 200 feet apart (Figure 4). The installation team would require a UXO escort. Signage would need to be surveyed and submitted to FTSWs Geographic Information Systems, and annual inspections, maintenance, repair, and reports would be required until base closure or until the MEC pathway is otherwise remedied. Signage

is not difficult or prohibitively expensive to acquire or install, and no scarce materials or technologies are required for implementation of this alternative.

Community Acceptance
Community Acceptance of Alternative 2 is possible. While Alternative 2 does not inherently reduce potential for human exposure to explosive hazards, it does not restrict public access to large portions of hunting land.

State Acceptance
State Acceptance of Alternative 2 is less likely. While Alternative 2 may decrease the likelihood of unintentional interaction with MEC at the surface, it may not be considered a sufficient alteration to the pathway of human exposure to potential MEC.

Cost Estimate
Alternative 2 is considered a "moderate cost" alterative for this Site. The estimated cost to implement this alternative is $635,582. Support for this estimate is provided in Appendix A. For the purpose of cost-to-completion estimates, Army protocol dictates a period of 30 years be used to account for long term O&M of LUCs if no definitive closure date is known. While 30 years will be used for cost estimates, LUCs, if implemented, will be maintained until base closure or MEC at the site is otherwise remedied.

Alternative 2 is moderately effective at reducing the exposure of humans to MEC related hazards at the ground surface, however, it is not as effective as Alternative 3. Therefore, Alternative 2 is not retained for the Site.

4.2.3 Alternative 3- MEC Surface Clearance

Alternative 3 consists of a MEC surface clearance. MEC removal would be conducted by qualified UXO personnel who will identify and remove MEC at the surface. The survey will utilize analog magnetometers in areas that have not already been disturbed for development. MEC discovered would be removed and safely disposed of. The areas of the Site that are not known to have previously disturbed for development are shown in Figure 5, and cover a total of approximately 395 acres.

Additionally, given the historic use of the land, an institutional control on intrusive activities, whereby a review will be performed prior to intrusive work to determine the presence of risk due to MEC, will be implemented.

Alternative 3 could result in an NFA for the site, and involves the fewest land-use restrictions.

Long-term Effectiveness
Alternative 3 is effective in the long-term by providing empirical data on the location, disposition, and disposal of potential MEC items. These items would then be disposed of and removed from consideration in a MEC HA. An NFA could potentially be achieved for the site. Therefore, Alternative 3 would be very effective in the long-term.

Reduces TMV of Waste
Alternative 3 would most effectively mitigate unacceptable risk by removing any further MEC located at the ground surface. Alternative 3 physically reduces the volume of MEC at the Site. Complete cover of the ground surface at the MRS eliminates the MEC hazard to human receptors at the ground surface.

Short-term Effectiveness

Alternative 3 is effective in the short term. Unauthorized access would need to be temporarily restricted in conjunction with the removal activities in the event that additional MEC items are discovered and require removal.

Implementability

Alternative 3 is implementable with moderate ease. This alternative would require administrative efforts including preparation of necessary planning documents (e.g. a CMIP, Explosives Safety Submission [ESS], and an Accident Prevention Plan [APP]) for the removal action. The surface sweep would require a team of UXO technicians, a Senior UXO Supervisor (SUXOS), UXO Quality Control Specialist (UXOQCS), and UXO Safety Officer (UXOSO). The clearance will focus on items with some portion visible at the ground surface. MEC recovered would require safe and proper disposal. Technologies required would include magnetometers for the surface sweep. The surface removal would cover the entirety of the MRS that has not been previously disturbed during development, an estimated 395 acres (Figure 5).

Community Acceptance

Alternative 3 is likely to be accepted by the community. Alternative 3 is the most effective at mitigating the risk of human exposure to potential explosive hazard, and does not restrict public access to hunting land.

State Acceptance

Alternative 3 is likely to be accepted by the State. Alternative 3 is the most effective alternative in mitigating the risk of exposure of potential explosive hazard.

Cost Estimate

Alternative 3 is considered the higher cost alternative for this Site. The estimated cost to implement this alternative is $3,458,232. Support for this estimate is provided in Appendix A.

Alternative 3 is the most effective at reducing the exposure of humans to MEC related hazards, and could potentially result in an NFA for the Site. While the cost of Alternative 3 is greater than that of the other alternatives, Alternative 3 is the most effective, and results in the fewest land use restrictions.

5 SELECTION OF PREFERRED ALTERNATIVE

5.1 Preferred Alternative

Based on assessment of the alternatives described in the previous section, the preferred Corrective Action Alternative for this Site is Alternative 3- MEC Surface Clearance. This alternative is preferred because the Site is developed for long-term industrial and recreational land use with the installation of operational buildings (as discussed in Section 2.3.2 and Section 3.3), and the land is used for recreational use (hunting). By removing potential MEC at the surface, Alternative 3 is the most effective alternative to reducing the likelihood for humans to encounter MEC. Alternative 3 would result in the fewest land use restrictions, while potentially allowing the Site to achieve NFA status.

Alternative 3 would include a complete surface sweep of the MRS, consisting of a magnetometer-assisted visual survey and removal action of the areas of the Site that have not been previously investigated - approximately 395 acres (Figure 5). Implementation would require the approval of applicable planning documents (e.g. CMIP, APP, ESS) prior to mobilization. The surface clearance requires a team of qualified UXO technicians, a SUXOS, and a UXOSO. The surface clearance would provide 100% coverage of the undeveloped areas of the MRS using magnetometer assisted visual survey techniques to ensure complete removal of MEC on the ground surface. Safe and proper disposal of any MEC items recovered must be accounted for in the CMIP. A map of locations of MEC items recovered during the surface sweep will be provided upon completion.

Alternative 3 also includes provision for MEC awareness training for personnel involved in removal of material at the borrow pit in the MRS to prevent any potential unforeseen MEC hazards associated with continued excavation into the subsurface. This would include instruction on what to do in the event potential MEC is encountered (e.g. “The Three ‘R’s, Recognize, Retreat, Report”).

Given the historical use of the land, Alternative 3 will carry an institutional control whereby a review will be performed prior to initiation of intrusive work at the MRS to determine the presence of risk due to MEC in the subsurface that may not have been identified in the RFI.

Implementation of the surface clearance will remove any MEC present at the surface, rendering the pathway to MEC at the surface incomplete. Alternative 3 carries the additional benefit of not requiring long-term maintenance effort or cost while still mitigating exposure to MEC and limiting potential restrictions on land use.

5.2 Precedence in Support of the Preferred Alternative.

Surface MEC clearance utilizing mag/dig surveys are an industry standard technique in MMRP site remediation.

5.3 Schedule

It is estimated that the preparation and approval of CMIP documents will take nine months. Preparation and approval of the APP/ESS documents is estimated to take three months. Procurement and mobilization for the surface clearance is expected to take one month. The surface clearance is estimated to take three months. Demobilization is estimated to take half a month. Reporting after the field effort is expected to take six months. These are estimates and the actual schedule may vary.

6 REFERENCES

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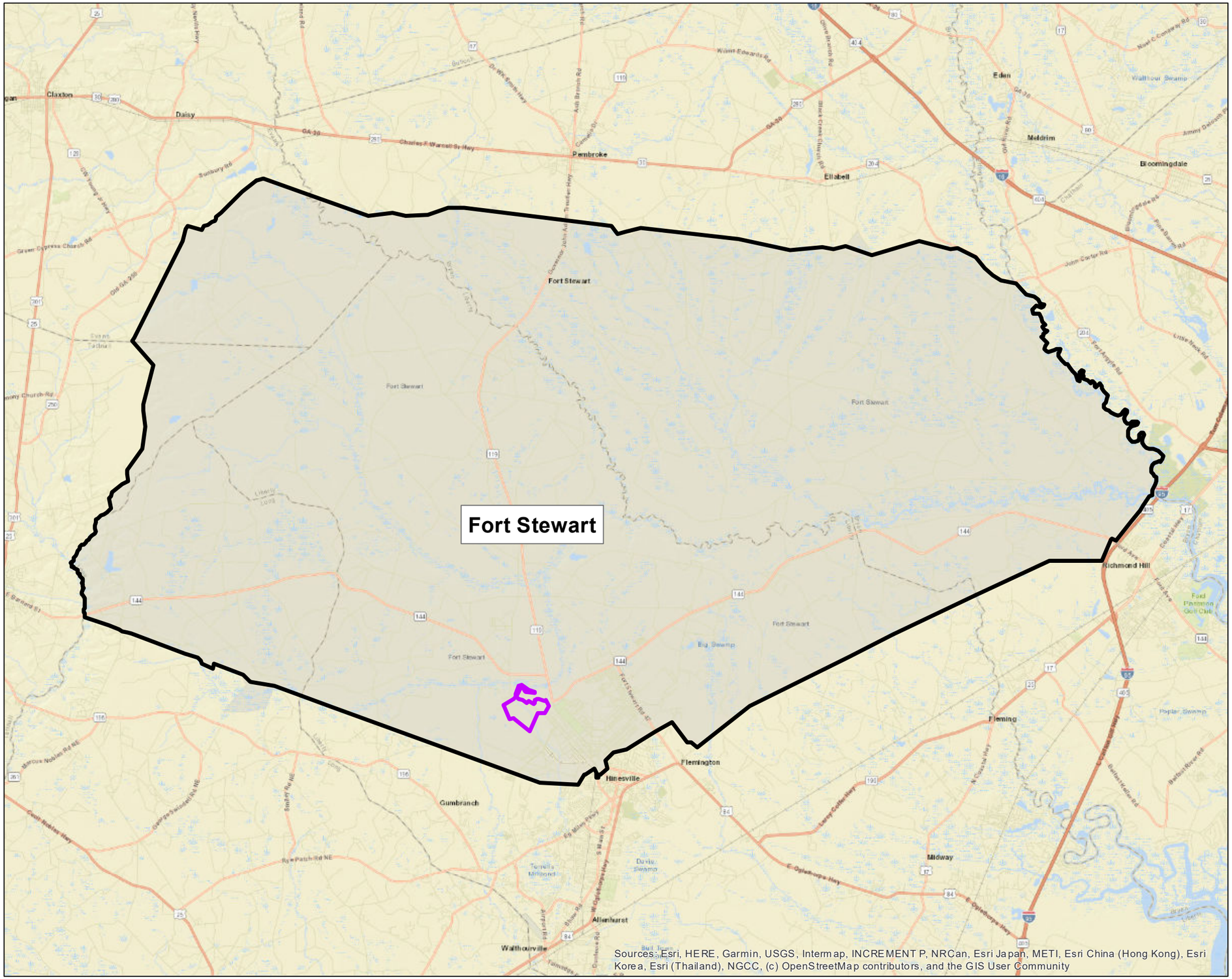
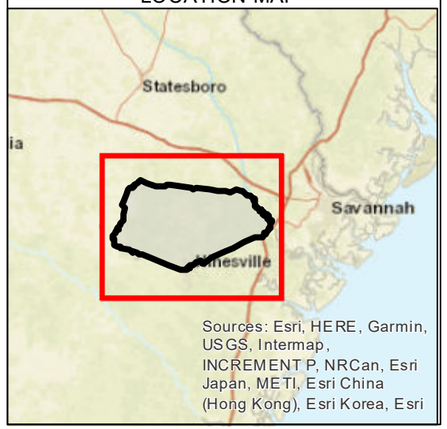
Figures



LEGEND

- Installation Boundary
- Anti-Tank Range 90-MM-2

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

0 2.5 5

Miles

TITLE

Installation Map and Site Location

KEMRON ENVIRONMENTAL SERVICES

Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

DRAWING DATE: 4/24/2020

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE

1

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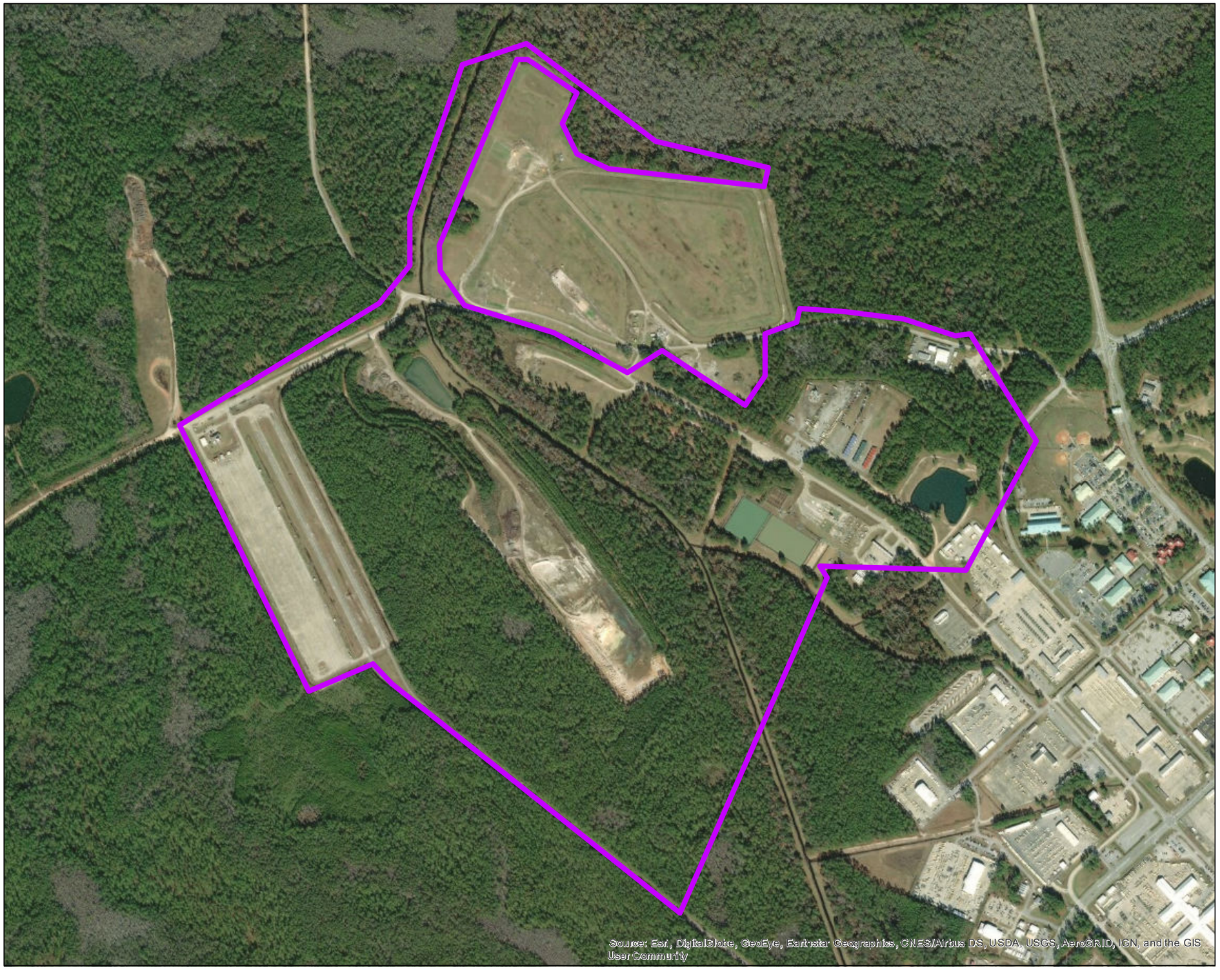
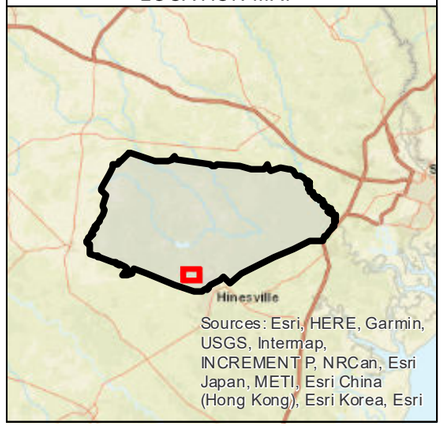


LEGEND

Anti-Tank Range 90-MM-2

Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

0 1,000 2,000

Feet

TITLE

Anti-Tank Range 90-MM-2 Site Map

KEMRON ENVIRONMENTAL SERVICES

Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

DRAWING DATE: 12/7/2019

Drawn by:	Reviewed by:
CJ	MSC

N

FIGURE

2

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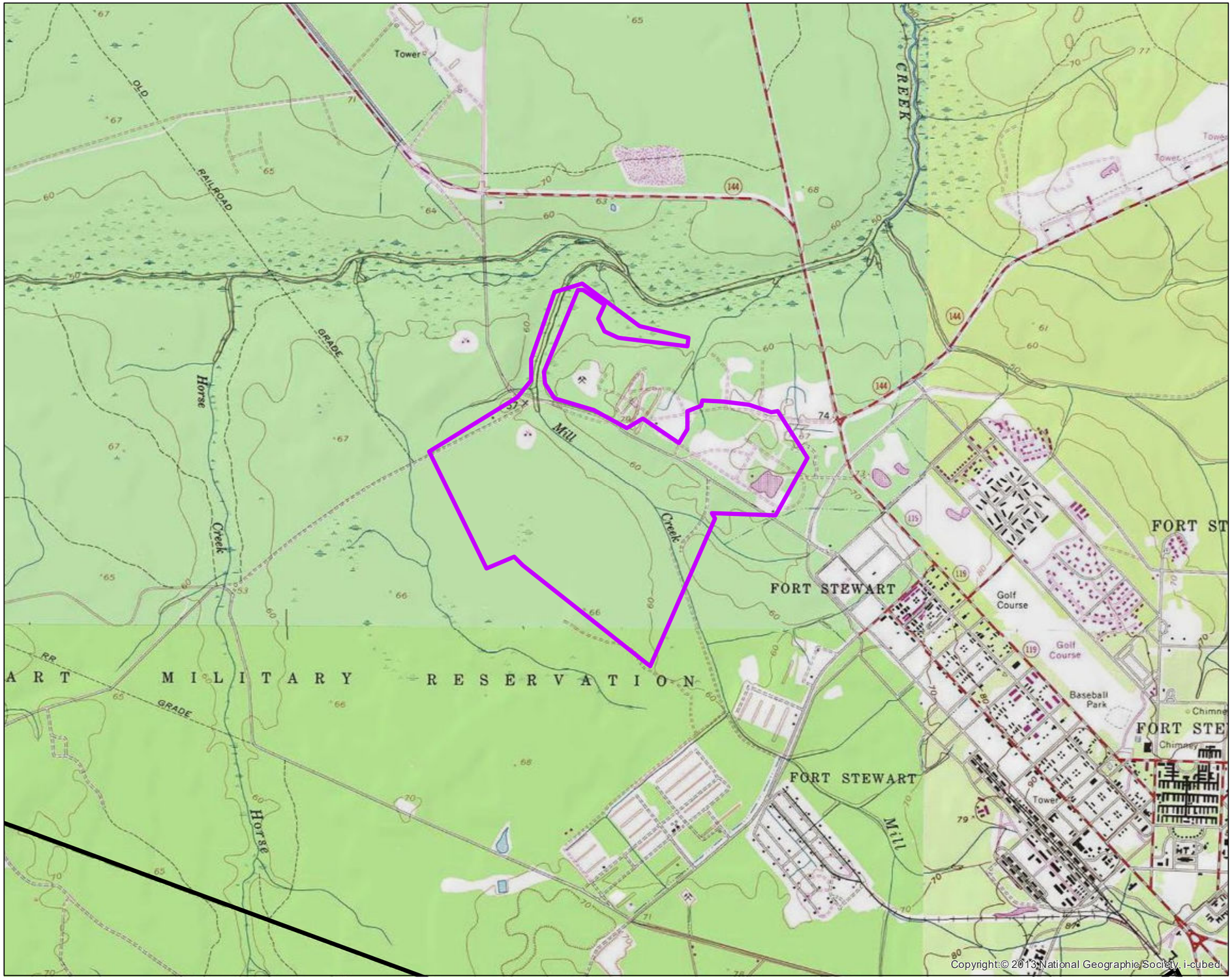
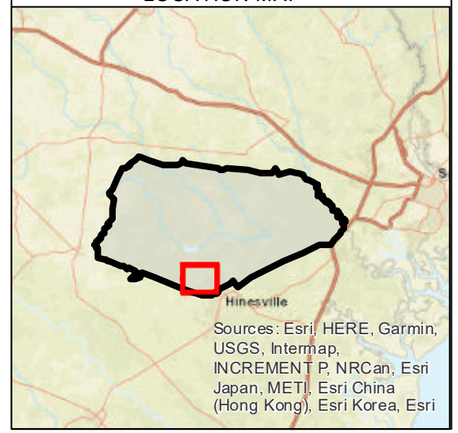


LEGEND

Anti-Tank Range 90-MM-2

Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

0 0.25 0.5

Miles

TITLE

Anti-Tank Range 90-MM-2 Topography

KEMRON ENVIRONMENTAL SERVICES

Fort Stewart

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1550 Veterans Parkway Building 1137
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FIGURE

3

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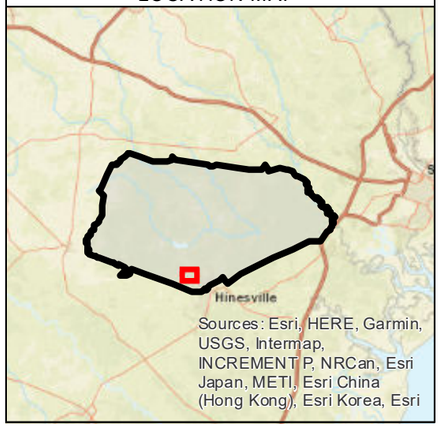
LEGEND

- Anti-Tank Range 90-MM-2
- Signs
- Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984, UTM Zone 17N (US Feet)

Sign placement is based on 200 ft spacing and undeveloped/undisturbed areas.

0 1,000 2,000

Feet

TITLE

Anti-Tank Range 90-MM-2
Alternative 2
LUCs

KEMRON ENVIRONMENTAL SERVICES

Fort Stewart

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Directorate of Public Works
1550 Veterans Parkway Building 1137
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FIGURE

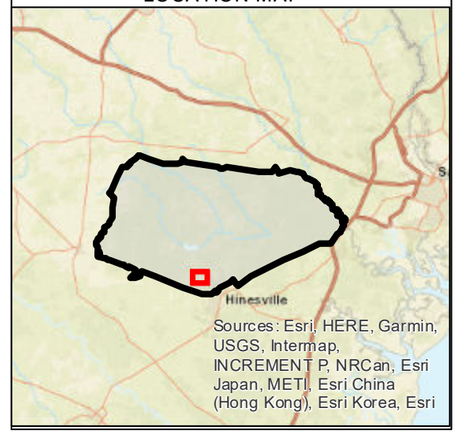
4

Document Path: M:\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Fort Stewart\MXDs\90MM2\4-90MM2 Alternative 2.mxd

LEGEND

- Anti-Tank Range 90-MM-2
- Areas to Clear
- Installation Boundary

LOCATION MAP



NOTES & SOURCES

Map Coordinates: WGS 1984
UTM Zone 17N (US Feet)

Areas to clear have not been previously investigated or disturbed for development.

0 1,000 2,000

Feet

TITLE

Anti-Tank Range 90-MM-2
Alternative 3
MEC Surface Clearance

KEMRON ENVIRONMENTAL SERVICES — Fort Stewart

PROJECT: U.S. Army Garrison - Fort Stewart
Directorate of Public Works
1550 Veterans Parkway Building 1137
USAG Fort Stewart, Georgia 31314

DRAWING DATE: 12/7/2019

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N

FIGURE

5

Document Path: M:\GIS\SH4943 - Ft Stewart Hunter Army Airfield\Fort Stewart\MXDs\90MM2\5-AT90MM2_Alternative3.mxd

Appendix A – Support for Cost Estimate

Table A-1: Anti-Tank Range 90-MM-2
Alternative 1: No Action

Capital Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Statement of Basis					
Statement of Basis and Response to Comments	1	LS	$15,000	$15,000	Includes Public Review and Meeting
SUBTOTAL (Statement of Basis)				$15,000	
Contingency (% of Sum)	12%			$1,800	
Project Management (% of Sum + Cont.)	8%			$1,344	
Total Capital Cost				**$18,144**	

Annual Costs
There are no annual costs associated with this Alternative

Periodic Costs
There are no periodic costs associated with this Alternative

Present Value Analysis					
Cost Type	**Year**	**Total Cost**	**Total Cost Per Year**	**Discount Factor (7%)**	**Present Value**
Capital	0	$18,144	$18,144	1.000	$18,144
Annual	1-30	$0	$0	12.409	$0
Periodic	NA	$0	$0	NA	$0
Total Present Value of Alternative					**$18,144**

Table A-2: Anti-Tank Range 90-MM-2
Alternative 2: Land Use Controls

Capital Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Statement of Basis					
Statement of Basis and Response to Comments	1	LS	$15,000	$15,000	Includes Public Review and Meeting
SUBTOTAL (Statement of Basis)				$15,000	
Land Use Controls					
Land Use Control Implementation Plan	1	LS	$20,000	$20,000	Includes design and placement of signs, details required institutional controls
Fence and Sign Installation	1	LS	$171,875	$171,875	Install signs around AOC
Institutional Controls	1	LS	$15,000	$15,000	Incorporating land use restrictions into all applicable documents
SUBTOTAL (Land Use Controls)				$206,875	
SUBTOTAL (All Activities)				$221,875	
Contingency (% of Sum)	10%			$22,188	
Project Management (% of Sum + Cont.)	5%			$12,203	
Construction Management (% of Sum + Cont.)	3%			$6,872	Excludes Statement of Basis
Total Capital Cost				**$263,138**	

Annual Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Fence and Sign Maintenance	1	LS	$14,470	$14,470	Replace missing and/or repair damaged signs annually for 30 years
LUC Status Report	1	LS	$1,500	$1,500	Annual Report for GA EPD
SUBTOTAL				$15,970	
Contingency (% of Sum)	10%			$1,597	
Project Management (% of Sum + Cont.)	5%			$878	
Total Annual Cost				**$18,445**	

Table A-2: Anti-Tank Range 90-MM-2
Alternative 2: Land Use Controls

Periodic Costs						
Description	**Year**	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Periodic Review Reports	See note	1	LS	$55,000	$55,000	Preparation of report at end of years 5, 10, 15, 20, 25, and 30
SUBTOTAL					$55,000	
Contingency (% of Sum)		12%			$6,600	
Project Management (% of Sum + Cont.)		8%			$4,928	
Total Periodic Costs					**$66,528**	

Present Value Analysis					
Cost Type	**Year**	**Total Cost**	**Total Cost Per Year**	**Discount Factor (7%)**	**Present Value**
Capital	0	$263,138	$263,138	1.000	$263,138
Annual	1-30	$553,361	$18,445	12.409	$228,889
Periodic	5	$66,528	$66,528	0.713	$47,434
Periodic	10	$66,528	$66,528	0.508	$33,819
Periodic	15	$66,528	$66,528	0.362	$24,113
Periodic	20	$66,528	$66,528	0.258	$17,192
Periodic	25	$66,528	$66,528	0.184	$12,258
Periodic	30	$66,528	$66,528	0.131	$8,740
Total Present Value of Alternative					**$635,582**

Table A-3: Anti-Tank Range 90-MM-2
Alternative 3: MEC Surface Clearance

Capital Costs					
Description	**Quantity**	**Units**	**Unit Cost**	**Total Cost**	**Notes/Assumptions**
Statement of Basis					
Statement of Basis and Response to Comments	1	LS	$15,000	$15,000	Includes Public Review and Meeting
SUBTOTAL (Statement of Basis)				$15,000	
MEC Surface Clearance					
Planning Documents	1	LS	$25,000	$25,000	Explosive Safety Submission, Work Plan, Accident Prevention Plan
Mobilization/Demobilization	1	LS	$20,000	$20,000	Personnel and equipment
Surface Clearance	1	LS	$2,459,000	$2,459,000	
Demolition	1	LS	$40,700	$40,700	
Disposal	1	LS	$20,250	$20,250	
Completion Report	1	LS	$16,000	$16,000	
SUBTOTAL (MEC Surface Clearance)				$2,580,950	
SUBTOTAL				$2,595,950	
Contingency (% of Sum)	12%			$311,514	
Project Management (% of Sum + Cont.)	8%			$232,597.12	
Remedial Design (% of Sum + Cont.)	5%			$144,623.20	Excludes Statement of Basis
Construction Management (% of Sum + Cont.)	6%			$173,547.84	Excludes Statement of Basis
Total Capital Cost				**$3,458,232**	

Annual Costs
There are no annual costs associated with this Alternative following completion of MEC Clearance

Periodic Costs
There are no periodic costs associated with this Alternative following completion of MEC Clearance

Table A-3: Anti-Tank Range 90-MM-2
Alternative 3: MEC Surface Clearance

Present Value Analysis					
Cost Type	**Year**	**Total Cost**	**Total Cost Per Year**	**Discount Factor (7%)**	**Present Value**
Capital	0	$3,458,232	$3,458,232	1.000	$3,458,232
Annual	1-30	$0	$0	12.409	$0
Periodic	NA	$0	$0	NA	$0
Total Present Value of Alternative					**$3,458,232**