Final

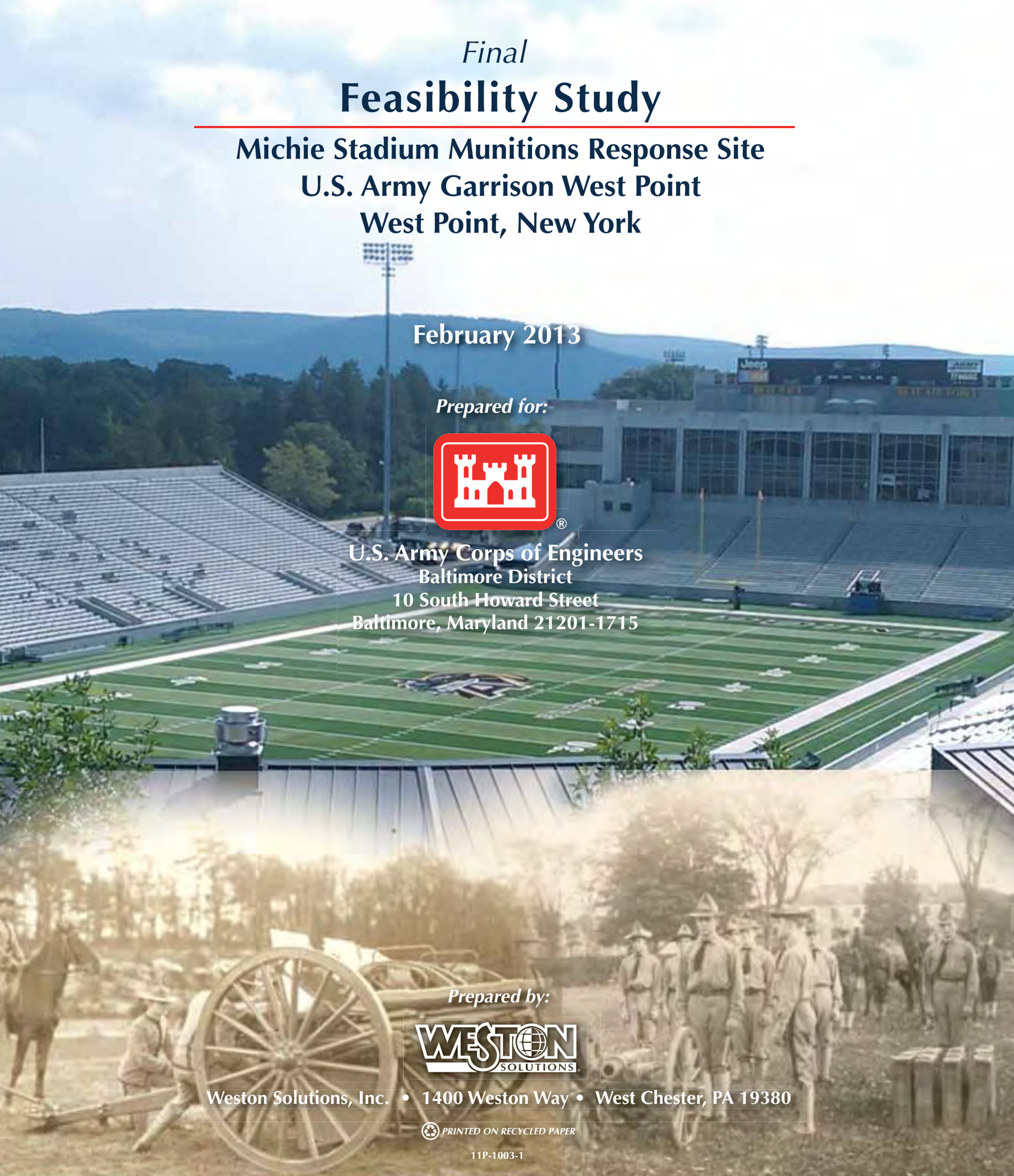
Feasibility Study

Michie Stadium Munitions Response Site
U.S. Army Garrison West Point
West Point, New York

February 2013

Prepared for:

U.S. Army Corps of Engineers
Baltimore District
10 South Howard Street
Baltimore, Maryland 21201-1715



Prepared by:

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FINAL
FEASIBILITY STUDY

MICHIE STADIUM MUNITIONS RESPONSE SITE
U.S. ARMY GARRISON WEST POINT
WEST POINT, NEW YORK

Contract No.: W912DR-09-D-0006
DELIVERY ORDER NO.: 0001

Prepared For:

U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
10 South Howard Street
Baltimore, Maryland 21201-1715

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WESTON SOLUTIONS, INC. PROJECT NO.: 03886.551.001.0102

February 2013

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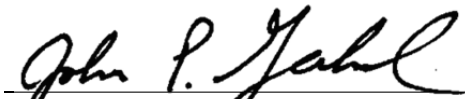
Feasibility Study

For Michie Stadium Munitions Response Site

U.S. Army Garrison West Point

WESTON – Technical Manager
Ryan Steigerwalt, P.G.

2/26/2013
Date



WESTON – Project Manager
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2/26/2013
Date

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LIST OF ACRONYMS AND ABBREVIATIONS

ºF	degrees Fahrenheit
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
BIP	blown-in-place
BUD	Berkeley UXO Discriminator
CDC	Contained Detonation Chamber
CENAB	United States Army Corps of Engineers, Baltimore District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CTT	closed, transferred, and transferring
DERP	Defense Environmental Restoration Program
DGM	digital geophysical mapping
DGPS	Differential Global Positioning System
DMM	discarded military munitions
DoD	Department of Defense
EMI	electromagnetic induction
EOD	Explosive Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ESTCP	Environmental Security Technology Certification Program
FDEMI	frequency-domain electromagnetic induction
FS	feasibility study
gpm	gallons per minute
GPS	Global Positioning System
IR	infrared
LUC	land use controls
LUCP	Land Use Control Plan
MAMMS	Multiple Award Military Munitions Services
MC	munitions constituents
MD	munitions debris
MEC	munitions and explosives of concern
MEC HA	Explosives of Concern Hazard Assessment
MGFD	munition with the greatest fragmentation distance
MMRP	Military Munitions Response Program
MPV	Man Portable Vector
MRS	Munitions Response Site
MSD	minimum separation distance
NCP	National Oil and Hazardous Substances Pollution Contingency Plan

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

NYNHP	New York Natural Heritage Program
NYSDEC	New York State Department of Environmental Conservation
O&M	operations and maintenance
PA	Preliminary Assessment
PPE	personal protective equipment
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
RAO	remedial action objective
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RSP	Render Safe Procedures
RTS	Robotic Total Station
SAM	Sub Audio Magnetics
SAR	Synthetic Aperture Radar
SARA	Superfund Amendments and Reauthorization Act of 1986
SI	site inspection
TAL	Target Analyte List
TBC	To Be Considered criteria
TBD	to be determined
TCL	Target Compound List
TDEMI	time-domain electromagnetic induction
TMV	toxicity, mobility, or volume
TNT	trinitrotoluene
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USMA	United States Military Academy
UXO	unexploded ordnance
West Point	U.S. Army Garrison West Point
WESTON®	Weston Solutions, Inc.

1. INTRODUCTION

The United States Army Corps of Engineers (USACE), Baltimore District (CENAB) contracted Weston Solutions, Inc. (WESTON®) to complete a feasibility study (FS) for the U.S. Army Garrison West Point (West Point) Michie Stadium Munitions Response Site (MRS) (WSTPT-022-R-01). The Michie Stadium MRS is one of the MRSs included in the Defense Environmental Restoration Program (DERP) Military Munitions Response Program (MMRP). This FS is developed under the MMRP to address munitions and explosives of concern (MEC) potentially present at the Michie Stadium MRS.

The remedial investigation (RI) and FS process was developed in response to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA). This FS for the Michie Stadium MRS is prepared to be consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), the U.S. Army MMRP document, *Final Munitions Response Remedial Investigation/Feasibility Study Guidance* (U.S. Army, 2009), and the U.S. Environmental Protection Agency (EPA) document, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988). The project is being conducted under the USACE Multiple Award Military Munitions Services (MAMMS) Contract W912DR-09-D-006, Delivery Order 0001.

1.1 PURPOSE

The purpose of the FS for the Michie Stadium MRS is to identify, develop, and perform a detailed analysis of potential remedial alternatives that would meet the remedial action objective (RAO) and thus afford the decision-makers adequate information to select the most appropriate remedial alternative(s) for the Michie Stadium MRS. The selected alternatives are expected to mitigate, reduce, or eliminate unacceptable risks to human health and the environment from MEC, based on the current and intended future use of the property.

The following major steps are involved in the development of the FS:

- Identification of RAOs (Section 1.4).
- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered criteria (TBCs) (Section 2).
- Identification of general remedial actions (Section 3).
- Identification and screening of potentially applicable remedial technologies and process options for the general response actions (Section 3).

- Development and screening of a range of remedial alternatives for the MRS based on combinations of the remedial technologies that were retained (Section 4).
- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria as required by the NCP (Section 5).
- Identification of the most appropriate/viable remedial alternative(s) that meet the RAOs (Section 5).

1.2 PROJECT BACKGROUND

West Point is located in Orange and Putnam Counties, New York, on the west bank of the Hudson River. West Point is approximately 50 miles north of New York City and approximately 13 miles south of Newburgh. In its entirety, West Point encompasses 15,974 acres that are designated as two areas, the Main Post or campus (2,530 acres) and the Military Reservation (13,444 acres). The Main Post includes the majority of the academic, residential, and support facilities. The Military Reservation is largely undeveloped and contains operational training facilities such as firing ranges and bivouac areas used during the summer to house and train cadets. The Michie Stadium MRS (WSTPT-022-R-01) comprises 14.1 acres of West Point, which is owned and managed by the U.S. Army. The Michie Stadium MRS lies within Orange County and is part of the Main Post area of West Point. **Figure 1-1** provides a regional view of West Point.

The Michie Stadium MRS is bounded by Howze Field to the south of the stadium, Holleder Sports Center to the southwest, and Lusk Reservoir to the east. The MRS intersects a capped landfill at parking Lot A to the west and extends about 200 feet north of Stony Lonesome Road to the north. Several athletic complexes, including the Holleder Center, Howze Field, the Kimsey Athletic Center, and Randall Hall, are located within or immediately adjacent to the MRS (**Figure 1-2**).

Since the establishment of West Point in 1802, the Michie Stadium area has been part of the Main Post and has been used for recreational and athletic activities. In 1909, there was a restoration project at Fort Putnam, which is located north of the MRS. In addition, there was a major earth and rock excavation and reworking of material for the new stadium. Earthmoving activities for the new stadium began in August 1923 with massive amounts of bedrock being removed from the southern edge of the Fort Putnam ridge because extensive filling was necessary to stabilize what had once been a low-lying, seasonally inundated area (Bedford, 2000; TLI, 2006). Additional removal of bedrock and reworking of fill material also occurred at the north end of the MRS during a 2001-2002 extension of Stony Lonesome Road. Although future plans within the MRS include the construction of an additional athletic building, no change to the current land use (recreational and athletic activities) is anticipated.

In 2001, a seismic upgrade that involved the addition of pilings to the west stands for increased stability was performed at Michie Stadium. During this seismic upgrade project, five 3-inch MKI Stokes mortars were found. Beginning in September 2003, Randall Hall, located at the south end of Michie Stadium, was constructed between the west stands of Michie Stadium and the Kimsey Athletic Center. Nine 3-inch Stokes mortars were found during the construction of Randall Hall.

In 2003, the United States (U.S.) Congress established the MMRP under the DERP to address MEC and munitions constituents (MC) located on current and former defense sites. Properties classified as operational military ranges are not eligible for the MMRP. The DERP, including the MMRP, typically follows CERCLA and the NCP. The U.S. Army conducted an inventory of closed, transferred, and transferring (CTT) military ranges and defense sites (also known as the Phase 3 CTT), which meets the requirements of a CERCLA Preliminary Assessment (PA). In this Phase 3 CTT at West Point, 10 closed ranges and 2 transferred areas with the potential for MEC, which includes both unexploded ordnance (UXO) and discarded military munitions (DMM) and/or MC, were identified as eligible for action under the MMRP. The Phase 3 CTT Range Inventory Report for West Point, which was completed in August 2004, included the Michie Stadium MRS.

The next phase of the CERCLA process at the Michie Stadium MRS was the site inspection (SI). The SI field activities at the Michie Stadium MRS were conducted in spring 2006 and included approximately 2.2 linear miles of visual surveys and MC sampling. No MEC or munitions debris (MD) was observed during the visual surveys. Because no evidence of military munitions was observed at the MRS during the visual survey, one soil sample (the minimum required) was collected from a grassy area in the northeast corner of the MRS. The sample was analyzed for Target Compound List (TCL) explosives by Method 8330 and a subset of the Target Analyte List (TAL) metals by Methods SW846 6010B and 7471A. Metals were selected for analysis based on the metals that were known to be associated with the munitions that West Point historically used. The metals analyzed included antimony, copper, iron, lead, mercury, potassium, and zinc. Because background data were not available for the West Point area, the analytical results for seven TAL metals and TCL explosives were compared, for evaluation purposes only, against EPA Region 9 preliminary remediation goals (PRGs) for residential soils, where available. MC was not detected above EPA Region 9 PRGs for residential soils. The SI recommended further evaluation of the Michie Stadium MRS for MEC during the RI phase of the CERCLA process. The SI report also recommended no further action for MC unless high concentrations of MEC and MD are identified.

The RI (WESTON, 2012) field work was conducted between April and June 2011 to characterize the nature and extent of MEC and MC on the ground surface and in the subsurface of the Michie Stadium MRS. During the RI characterization, it was confirmed that MC investigations were not warranted. The data collected during the field investigation and the conclusions presented in the RI were used to develop the FS.

1.3 SUMMARY OF REMEDIAL INVESTIGATION RESULTS

This section provides a summary of the environmental setting and the results of the RI conducted at the Michie Stadium MRS, including the nature, extent, and hazards associated with MEC. MC was determined not to pose a significant risk to human health or the environment as indicated by the human health and ecological risk assessments. The results of the RI are discussed in greater detail in the *Final Remedial Investigation Report, Michie Stadium Munitions Response Site, U.S. Army Garrison West Point, West Point, NY* (WESTON, 2012).

1.3.1 Environmental Setting

1.3.1.1 Climate

The climate of the region including West Point is characterized as a humid, continental climate. Summers are warm and have periods of high humidity. The semi-permanent Bermuda High brings south to southwest warm and humid air to the area. July is the hottest month, with a mean temperature of 86 degrees Fahrenheit (ºF); and the coldest month of the year is January, which has a mean temperature of 27 ºF. Winters are cold with extended periods of snow cover and are influenced by the cold Hudson Bay air masses. Most winters are characterized by one or more warm periods when soils nearly or completely thaw (Tetra Tech, Inc., 2011).

A third weather pattern that influences the climate of West Point is an air mass that flows inland from the North Atlantic Ocean and brings cool, cloudy, and damp weather to the region. Prevailing winds are generally westerly (Tetra Tech, Inc., 2011).

Thunderstorms occur approximately 20 times per year. Tornadoes occur 3 to 4 times a year in the region, although no significant tornadoes have occurred at West Point for more than 20 years. Total annual precipitation is greater than 49.5 inches, with the least amount (approximately 3.5 inches each month) occurring in January and February, and the most occurring in May (approximately 4.9 inches) (Tetra Tech, Inc., 2011).

1.3.1.2 Geology

West Point lies in the Hudson Highlands, a low, rugged mountain range that forms a zone of folded and faulted metamorphic and igneous rocks subjected to extensive weathering and erosion. Precambrian-age granite, diorite, gneiss, and schist compose the majority of the crystalline bedrock underlying West Point. Granite, the most prevalent rock type in the bedrock, is typically medium-grained and composed of quartz, feldspar, and mica. Granite and pegmatite are igneous rocks and occur as dikes and sills within the gneiss. Igneous rocks on the installation consist of plagioclase feldspar, hornblende, pyroxene, and biotite mica and quartz (Tetra Tech, Inc., 2011).

The metamorphic rocks of West Point exist in sequences. These sequences are composed of a hard, layered, banded rock, gneiss, which is sometimes intruded by igneous rocks. Marble, quartzite, schist, and amphibolite are other metamorphic rocks present in the Highlands area. The metamorphic rocks were deposited as marine sediments, volcanic ashes, and volcanic rocks. During the Precambrian period, these sediments and rocks were possibly subject to three phases of folding—extensive regional metamorphism, partial melting, and magmatic intrusion. The cantonment area, which is bounded by the Hudson River, is underlain by exposed bedrock and glacial alluvium (Tetra Tech, Inc., 2011).

Faults mapped at the surface near and within the inhabited portions (most of the developed areas) at West Point include the Long Pond, the Crown Ridge, and the Highland Brook faults. The Long Pond fault trends northeast-southwest along the northwestern boundary of West Point and the Storm King Highway (NY Route 218). The Crown Ridge fault also trends northeast-southwest and extends through Lusk Reservoir. The Highland Brook fault trends northwest-southeast along Route 9W and the Storm King Highway between the Long Pond and Crown Ridge faults (Tetra Tech, Inc., 2011).

Surficial geologic formations on the installation are outcroppings, talus, and glacial deposits. During glacier retreat, features were formed along the valley walls. The most prominent features are the kame terraces. In all but the flat, marshy areas, bedrock can be observed. A thin veneer layer of Pleistocene-age glacial deposits, both stratified and unstratified, overlies the igneous and metamorphic bedrock sequence. The stratified drift consists primarily of sand and gravel deposited in glacial lakes and streams. The unstratified drift consists of glacial till material, which is mainly large boulders and clay, sand, and gravel deposited directly from glacial ice as it progressed or regressed across the area (Tetra Tech, Inc., 2011).

Site-specific geologic investigations were not conducted for the Michie Stadium MRS. The boring data from nearby monitoring wells are not relevant because of a distance of several hundred feet and an elevation difference of approximately 80 feet. Regional geologic maps (Cadwell, 1989; Fisher et al.,

1970) indicate that the bedrock geology of the Michie Stadium MRS is gneiss underlain by biotite granitic gneiss. Bedrock is very shallow with many outcroppings, as shown in **Figure 1-3.**

1.3.1.3 Topography

The topography of West Point is best described as having moderately steep hills and numerous escarpments. Slopes from 10 to 60% are common on the installation. Areas between the hills are interspersed with small plains, basins, and narrow valleys with slopes less than 3%. The topography of the surrounding region is undulating and rugged. These characteristics, along with the alluvium and till deposits in the lowland areas and the relatively flat valley bottoms of the region, are the result of glaciation (Tetra Tech, Inc., 2011). Because the MRS is extensively developed with athletic facilities and impervious surfaces, the topography is relatively flat; however, a small area along the northern edge of the MRS includes wooded, hilly terrain. The MRS lies at an elevation of approximately 320 feet (97 meters) above mean sea level (amsl).

1.3.1.4 Soils

The soil types within the Michie Stadium MRS include smoothed udorthents, moderately steep Hollis Complex rock outcrop, sloping Hollis Complex rock outcrop, and sloping Swartswood-Mardin very stony soils (**Figure 1-3**). Smoothed udorthents, which comprise a majority of the MRS, are located in the developed area that includes Michie Stadium. These are excessively to moderately well drained soils that are characteristic of man-made cut-and-fill areas.

The Swartswood-Mardin and Hollis Complex soils are located in the areas investigated during the SI and RI. These soil types range from well drained to excessively well drained. The Hollis Complex soils typically have a thin leaf mat over dark, gravelly and sandy loam and contain protruding rock outcrops and ledges of bedrock. Available water capacity in the Hollis Complex soils is low or very low. The Swartswood-Mardin surface soils contain primarily gravelly loam, gravelly silt loam, gravelly fine sandy loam, or channery sandy loam. Surface boulders greater than 10 inches in diameter are common. It is common for Swartswood-Mardin soils to contain a perched water table in the spring. Available water capacity is low to moderate, indicating that Swartswood-Mardin soils could be more susceptible to frost heave that the other soils within the MRS.

1.3.1.5 Hydrogeology

1.3.1.5.1 Surface Water

Although no surface water resources exist within the Michie Stadium MRS, the Lusk Reservoir is immediately adjacent to this MRS and several water bodies are located within a 2.9-mile radius: the Hudson River, Dassori Pond, Delafield Pond, Crow's Nest Brook, Sinclair Pond Brook, and Kinsley Farm Brook. Sheet flow within the MRS is directed to Kinsley Farm Brook.

1.3.1.5.2 Groundwater

Groundwater on West Point occurs in an unconsolidated aquifer consisting of alluvial deposits and a consolidated bedrock aquifer. Water within the unconsolidated aquifer occurs primarily in the sands and gravels of the stratified drift deposits. These deposits represent the most prolific sources of groundwater on the installation, but the deposits are thin and generally have fairly small well yields that average about 40 gallons per minute (gpm). Water in the unconsolidated aquifer usually occurs under water table conditions. Recharge to the aquifer is primarily from local precipitation, but hydrologic communication occurs between the alluvial and the bedrock aquifers, and some upward seepage from the bedrock aquifer occurs in low-lying areas (Tetra Tech, Inc., 2011; TLI, 2007). However, an unconsolidated aquifer does not exist within the Michie Stadium MRS based on the geology.

Site-specific groundwater investigations were not conducted for the Michie Stadium MRS. The data from nearby monitoring wells are not applicable because of a distance of several hundred feet and an elevation difference of approximately 80 feet.

1.3.1.6 Ecology

West Point lies in New York State along the border of the west bank of the Hudson River in the lower Hudson River Valley. Its environmental setting is unique in that five physiographic provinces—the Appalachian Plateaus, Folded Appalachians (Valley and Ridge), New England, Piedmont, and Coastal Plain—converge within a 35-mile radius of the installation. West Point is located in the New England Province in an area known as the Hudson Highlands (Tetra Tech, Inc., 2011).

1.3.1.6.1 Special Natural Areas

West Point has identified 12 sites that are to be specially managed because of ecological or geological significance, unique geological structure, and/or aesthetic and educational value to the installation; however, the Michie Stadium MRS is not located within or adjacent to any of the 12 identified sites (Tetra Tech, Inc., 2011).

1.3.1.6.2 Wetlands

Approximately 1,010 acres of wetlands are located throughout West Point in association with streams, ponds, depressions, and seeps (Tetra Tech, Inc., 2011); however, the Michie Stadium MRS does not contain wetlands (TLI, 2007; WESTON, 2011).

1.3.1.6.3 Flora

Vegetation within the Michie Stadium MRS is limited to mowed lawn and trees that are characteristic of developed, landscaped areas with pockets of mature hardwood forest and or dense vegetation consisting of small saplings, mountain laurel, blueberry, briers, and vines (TLI, 2007).

1.3.1.6.4 Fauna

Forty-eight species of mammals, 249 species of birds, 22 species of reptiles, and 18 species of amphibians have been documented on West Point, in addition to many species of fish and invertebrate species (Tetra Tech, Inc., 2011). Because the Michie Stadium MRS is extensively developed, it is unlikely that most of these species are present in the Michie Stadium MRS.

1.3.1.6.5 Ecological Receptors

Potential ecological receptors are presented in the overall CSM for West Point and are listed below:

- Mammals: Small-footed bat and Indiana bat.
- Birds: Cooper's hawk, Northern goshawk, sharp-shinned hawk, golden eagle, American bittern, red-shouldered hawk, whip-poor-will, common nighthawk, cerulean warbler, Peregrine falcon, common loon, bald eagle, yellow-breasted chat, least bittern, red-headed woodpecker, osprey, pied-billed grebe, vesper sparrow, and golden-winged warbler.
- Reptiles: Eastern wormsnake, spotted turtle, wood turtle, timber rattlesnake, Eastern hognose, and Eastern box turtle.
- Amphibians: Jefferson salamander, blue-spotted salamander, and marbled salamander.
- Fish: Shortnose sturgeon, Atlantic sturgeon, and Atlantic silverside.
- Insects, Dragonflies, and Damselflies: Lateral bluet, Needham's skimmer.
- S1* Plants: Virginia snakeroot, glomerate sedge, stripe-fruited sedge, and Carolina cranesbill.
- S2* Plants: Long's bittercress, midland sedge, slender crabgrass, violet wood sorrel, Carey's smartweed, and small-flowered crowfoot.

- S2S3* Plants: Cluster sedge, purple milkweed, Emmon's sedge, Bicknell's sedge, Bush's sedge, false hop sedge, weak stellate sedge, yellow harlequin, racemed pinweed, violet bush clover, slender knotweed, and gemmed bladderwort.

*Notes:

S1 = Critically imperiled in New York State because of extreme rarity (5 or fewer sites or very few remaining individuals) or extremely vulnerable to extirpation from New York State due to biological or human factors.

S2 = Imperiled in New York State because of rarity (6 to 20 sites or few remaining individuals) or highly vulnerable to extirpation from New York State due to biological or human factors.

S3 = Rare in New York State (usually 21 to 35 extant sites).

Double Ranks (i.e., S2S3) = The first rank indicates rarity based upon current documentation. The second rank indicates the probable rarity after all historical records and likely habitat have been checked.

1.3.1.7 Sensitive Environment Resources within the MRS

WESTON submitted a request for review by the New York Natural Heritage Program (NYNHP) to determine whether there are records of any known rare, threatened, and endangered species or species of special concern located within or near the West Point MRSs. In response, the NYNHP identified the following species for the potential to occur within the West Point MRSs: one mammal species (small-footed myotis (bat) [*Myotis leibii*]), two species of birds (bald eagle [*Haliaeetus leucocephalus*] and the least bittern [*Ixobrychus exilis*]), one reptile species (timber rattlesnake [*Crotalus horridus*]), three fish (shortnose sturgeon [*Acipenser brevirostrum*], Atlantic sturgeon [*Acipenser oxyrhynchus*], and Atlantic silverside [*Menidia menidia*]), and one insect (Needham's skimmer [*Libellula needhami*]). With the exception of the three fish species, the remaining species have the potential to occur within the Michie Stadium MRS; however, because of the degree of development and the level of activity, it is unlikely that any of these species would be permanent residents within the MRS. The NYNHP did not identify any federally threatened or endangered plant species within any of the West Point MRSs.

1.3.1.8 Cultural and Archaeological Resources

Because West Point is one of the older training grounds in the United States that is still intact, it contains numerous cultural, archaeological, and historical sites. Michie Stadium itself is a cultural resource (WESTON, 2011).

1.3.1.9 Demographics

The West Point Military Academy student body numbers 4,594. In addition to the Corps of Cadets, West Point is home to 1,785 active duty soldiers and 2,790 family members. Supporting the mission of the Academy is a civilian workforce of 2,750 personnel (Department of Defense (DoD) and MilitaryHOMEFRONT, 2012). The Michie Stadium MRS is easily accessible to West Point personnel,

residents, site visitors, recreational users (athletes), maintenance workers, and contractor personnel who have passed through initial post security at the entrance gate.

1.3.1.10 Current and Projected Land Use

Michie Stadium MRS is located within a Cadet Support area and is used for recreational and athletic activities. Michie Stadium is used for football and lacrosse events. Although future plans within the MRS include the construction of an additional athletic building (Lacrosse Center), no change to the current land use (recreational and athletic activities) is anticipated.

1.3.2 Munitions and Explosives of Concern

The term MEC distinguishes specific categories of military munitions that may pose unique explosive safety risks, including the following:

- **UXO**—Military munitions that fulfill the following criteria:
  - Have been primed, fuzed, armed, or otherwise prepared for action;
  - Have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and
  - Remain unexploded either by malfunction, design, or any other cause (DoD, 2008).
- **DMM**—Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include UXO, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (DoD, 2008).
- **MC**—The definition of MEC also includes chemicals such as trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) present in high enough concentrations to pose an explosive hazard (DoD, 2008).

MC refers to any materials originating from MEC; discarded military munitions; or other military munitions, including explosive and nonexplosive materials, and emission, degradation, or breakdown elements of such munitions (DoD, 2008).

MD was investigated during the RI as evidence of potential MEC. MD refers to any remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal (DoD, 2008).

1.3.2.1 Nature and Extent of Munitions and Explosives of Concern

A total of 0.43 acre of the Michie Stadium MRS was investigated using electromagnetic digital geophysical mapping (DGM) surveys to delineate the nature and extent of MEC. The geophysical survey coverage completed during the RI is presented in **Figure 1-4**. The remainder of the MRS was not accessible for geophysical mapping and intrusive investigation because of development, which includes buildings and structures; impermeable ground surfaces such as concrete and asphalt roads, parking areas, and walkways; and the playing field within Michie Stadium. A total of 242 anomalies were detected as a result of the DGM surveys. Each anomaly was reacquired and intrusively investigated. One MEC item (UXO, mortar, 3-inch Stokes, MKI, unfuzed) and seven MD items were recovered during intrusive investigations. The MD items included one tail boom and one end cap from 3-inch Stokes mortars and five fragments from unknown munitions. The remaining 234 anomalies were documented as cultural debris. The locations of the MEC and MD recovered during the RI are presented in **Figure 1-5. Table 1-1** presents the MEC and MD found during the RI.

Table 1-1 Summary of MEC and MD at the Michie Stadium MRS

Target ID#	Item Type	Item Description	Depth (inches)	Weight (pounds)
MS-01-28	UXO	Mortar, 3-inch Stokes, MKI, unfuzed	6	15.0
MS-02-75	MD	Mortar tail boom, 3-inch Stokes, MKI	0	0.1
MS-02-32	MD	Mortar end cap, 3-inch Stokes, MKI	0	0.5
MS-02-33	MD	Fragment, Unknown	3	1.0
MS-02-46	MD	Fragment, Unknown	3	1.0
MS-02-52	MD	Fragment, Unknown	0	1.0
MS-02-63	MD	Fragment, Unknown	3	1.0
MS-02-95	MD	Fragment, Unknown	0	1.0

MEC: Munitions of Explosive Concern
MD: Munitions Debris
UXO: Unexploded Ordnance

The UXO item was recovered at 6 inches bgs. The MD was recovered between 0 inches and 3 inches bgs. The remaining non-MD related material was recovered between 0 inches and 6 inches bgs. Because an impact area or other type of MEC release was not observed during the intrusive investigation, no MC characterization was warranted.

The MEC and MD recovered during the RI were most likely brought to the area within construction fill collected at different locations and transported to the MRS during various construction projects at Michie Stadium. It is unlikely that Stokes mortars were used within the vicinity of the Michie Stadium MRS, given the time frame during which they were designed and used (1914 to 1939) and the activities that

occurred in the vicinity of the Michie Stadium MRS during that time: a restored Fort Putnam existed to the north, and Michie Stadium was constructed and used for athletic events and recreation.

A review of the historical topographic maps was used to delineate the boundaries of the disturbance resulting from earthwork and the areas where MEC and MD were likely brought to the area in construction fill. The determination expanded the Michie Stadium MRS boundary to 14.1 acres to capture the extent of historically disturbed area (cut or fill). There is a low probability of encountering additional MEC and MD within the Michie Stadium MRS boundary as a result of the RI investigation coverage and the area that has been developed, which includes buildings and structures; impermeable ground surfaces, such as concrete and asphalt roads, parking areas, and walkways; and the playing field within Michie Stadium.

1.3.2.2 Munitions and Explosives of Concern Hazard Assessment

In October 2008, the Technical Working Group for Hazard Assessment, which included representatives from the DoD, Department of the Interior, EPA, and other officials, made available the technical reference document, *Interim Munitions and Explosives of Concern Hazard Assessment Methodology* (MEC HA) (EPA, 2008). This document is designed to be used as the CERCLA hazard assessment methodology for MRSs where there is an explosive hazard from the known or suspected presence of MEC. The MEC HA was used to assess the explosives hazards for the Michie Stadium MRS.

The MEC HA includes evaluation of three components of a potential explosive hazard incident:

- **Severity**—The potential consequences (e.g., death, severe injury, property damage) of MEC detonating.
- **Accessibility**—The likelihood that a receptor will be able to come in contact with MEC.
- **Sensitivity**—The likelihood that a receptor will be able to interact with MEC such that it will detonate.

Each of these components is assessed in the MEC HA by determining input factor scores for an MRS. The sum of the input factor scores falls within one of four defined ranges, called hazard levels. Each of the four levels reflects site attributes that describe groups of sites and site conditions ranging from the highest to the lowest hazards. The MEC HA hazard levels are as follows:

- **Hazard Level 1**—Sites with the highest hazard potential. There might be instances where an imminent threat to human health exists from MEC.

- **Hazard Level 2**—Sites with a high hazard potential. A site with surface MEC or one undergoing intrusive activities such that MEC would be encountered in the subsurface. The site would also have moderate or greater accessibility by the public.

- **Hazard Level 3**—Sites with a moderate hazard potential. A site that would be considered safe for the current land use without further munitions responses, although not necessarily suitable for reasonable, anticipated future use. Level 3 areas generally would have restricted access, a low number of contact hours, and, typically, MEC only in the subsurface.

- **Hazard Level 4**—Sites with a low hazard potential. A site compatible with current and reasonably anticipated future use. Level 4 sites typically have had a MEC cleanup performed.

The MEC HA fits into MMRP activities and the regulatory structure of CERCLA by addressing the NCP CFR 300.430(d)(4) requirement to conduct site-specific risk assessments for threats to human health and the environment; however, the MEC HA does not directly address environmental or ecological concerns that might be associated with MEC (EPA, 2008).

The MEC HA guidance document (EPA, 2008) includes an automated workbook that develops site scoring through standardized input and formulas. As part of the Michie Stadium RI, the automated workbook was used to provide a HA score. A summary of the MEC HA scoring for the Michie Stadium MRS is presented below.

Site ID: Michie Stadium MRS	Hazard Level	Category Score
Current Use Activities	4	525

Source: EPA MEC HA Worksheet V.1.2, 2007.

For current use activities, the Michie Stadium MRS has a Hazard Level Category of 4, which indicates the MRS has low potential explosive hazard conditions. The presence of MEC at an MRS means that an explosive hazard may exist. Therefore, MEC may continue to pose a hazard at a Hazard Level 4 MRS. Typical characteristics of Hazard Level 4 MRS include the following:

- A MEC cleanup was performed or MEC is located only in the subsurface, below the depth of receptor intrusive activities.

- The energetic material type is propellant, spotting charge, or incendiary.

- Accessibility is limited or very limited, and contact hours are few or very few. This may be the result of land use controls (LUCs). The current and future uses of the MRS are consistent.

1.4 REMEDIAL ACTION OBJECTIVES

The NCP CFR 300.430(e)(2)(i) specifies that RAOs be developed to address: (1) contaminants of concern, (2) media of concern, (3) potential exposure pathways, and (4) preliminary remediation levels.

RAOs are defined to determine the effectiveness of the remedial actions; developed for MEC based on the MRS requirements and exposure pathways; and focused on limiting or removing exposure pathways for MEC (U.S. Army, 2009). The RAO for the Michie Stadium MRS addresses the overall goal of managing risk and protecting human health from residual explosive hazards.

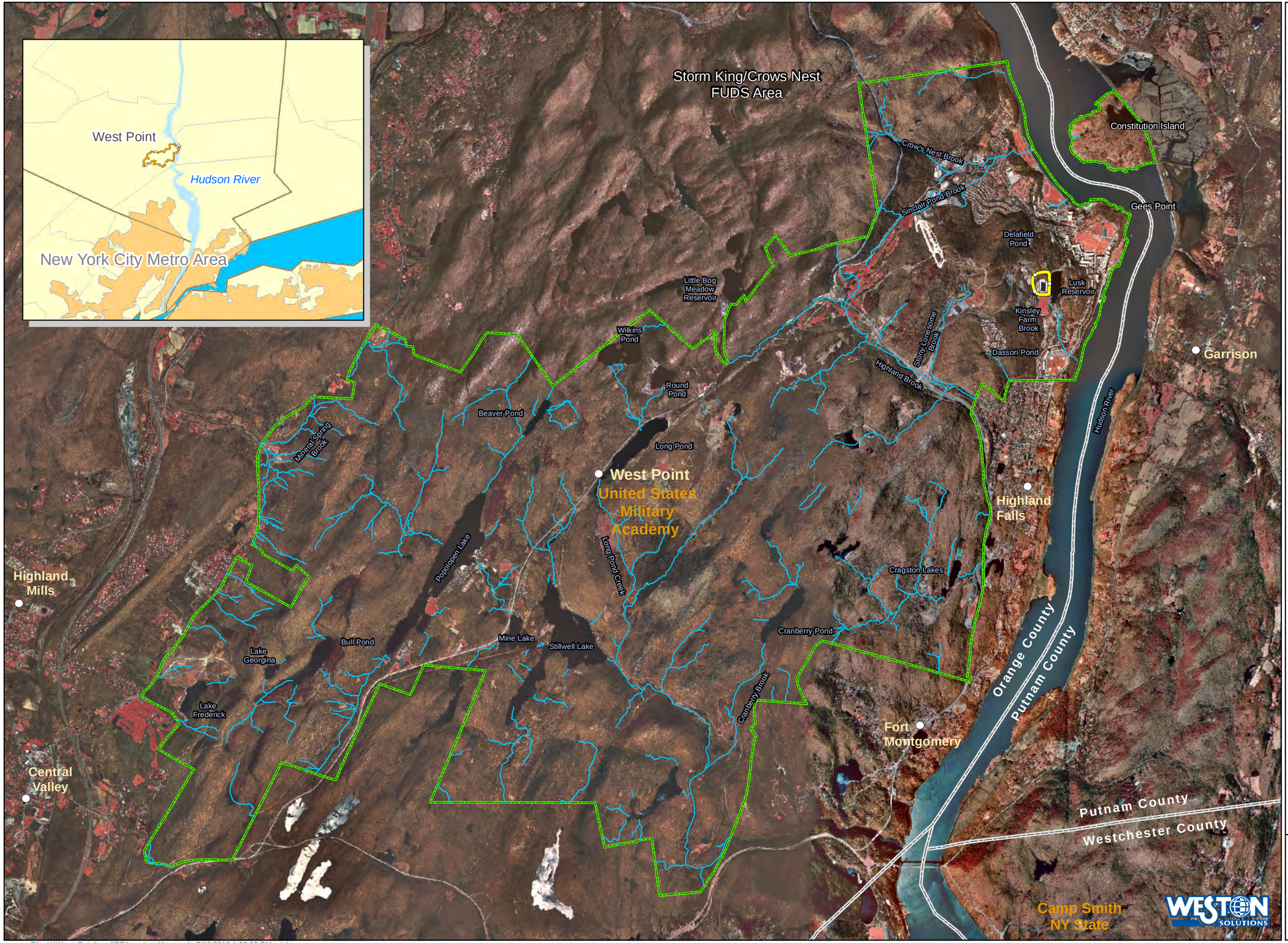
An analysis of the RI results in relation to the current and anticipated future land use of the Michie Stadium MRS indicates that there is an explosive safety hazard as a result of the potential for human receptors to come into contact with MEC in surface and subsurface soil. Only a small portion of the Michie Stadium MRS remains undeveloped where human exposure to surface and subsurface soil can occur. The majority of the Michie Stadium MRS includes buildings and structures and other impermeable ground surfaces such as concrete and asphalt roads, parking lots, walkways, and the Michie Stadium playing field. These structures and impermeable surfaces limit access to surface and subsurface soils where MEC may exist. No soil is present in some areas where bedrock is exposed. MEC and MD recovered during the RI were most likely brought to the area in construction fill collected at different locations and transported to the MRS during various construction projects at Michie Stadium. Although it is possible that MEC may be present at the Michie Stadium MRS based on the discoveries made during construction activities and the RI, there is a low potential explosive hazard condition.

The Michie Stadium MRS is used primarily for recreational and athletic activities. Although access to West Point is limited, recreational users and athletes, as well as regular maintenance and landscaping personnel, have access to the Michie Stadium MRS. The Michie Stadium MRS is also subject to future development such as the plans to construct an additional athletic building (Lacrosse Center); therefore, construction workers will have limited access to the MRS during construction. Because there is a potential for MEC to become exposed during these construction activities and because West Point personnel, athletes, and recreational users have access to the MRS, both surface and subsurface exposure pathways are considered potentially complete at the Michie Stadium MRS.

The RAO for the Michie Stadium MRS is to prevent direct contact of construction workers, West Point personnel, athletes, and recreational users with the explosive hazards posed by MEC in surface and subsurface soil. This Michie Stadium MRS FS assembles general response actions and technologies into implementable alternatives that satisfy this RAO.

SECTION 1

FIGURES



Legend

- Installation Boundary
- Michie Stadium - 14.1 Acres
- Streams

Imagery Source: Digital Orthophoto
USDA-FSA-APFO
November 2003

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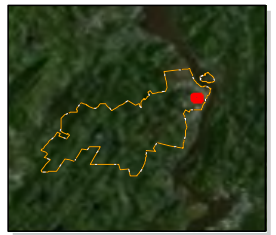
Miles

Figure 1-1
Regional Location Map
U.S. Army Garrison West Point

File: Y:\West_Point\mxd\ES\Location Map.mxd, 7/18/2012 1:22:35 PM, ricksc

Legend

Michie Stadium -14.1 Acres



Imagery Source: ESRI, Bing Mapping Service. 2011

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Figure 1-2
Michie Stadium MRS
(WSTPT-022-R-01)
U.S. Army Garrison West Point

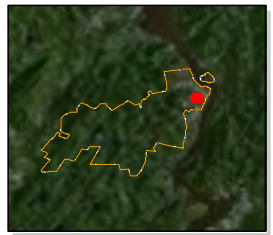
File: Y:\West_Point\mxd\FS\Michie_Stadium.mxd, 11/7/2012 9:35:39 AM, ricksc

Legend

- Michie Stadium -14.1 Acres

Michie Stadium Soil Series

- Rock Outcrop – Hollis Complex, moderately steep
- Rock Outcrop – Hollis Complex, sloping
- Swartswood-Mardin
- Udorthents



Imagery Source: ESRI, Bing Mapping Service. 2009

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Figure 1-3
Michie Stadium MRS
(WSTPT-022-R-01)
Soil Series
U.S. Army Garrison West Point

File: Y:\West_Point\mxd\FS\Michie_Stadium_Soils.mxd, 11/7/2012 9:36:42 AM, ricksc

Ft. Putnam
Schofield Place
SERVICE
Stony Lonesome Road
Delafield Road
SERVICE A & B LOT
SERVICE E LOT
MS-01
MS-02
WEST POINT
Lusk Reservoir
West Stands
Randall Hall
Kimsey Center
Mills Road
Stewart Road
SERVICE F LOT
Holleder Center
Howze Field
Howze Place
Partridge Place
Foley Center

Legend

Michie Stadium -14.1 Acres

DGM Survey Area

Area of Interest

Imagery Source: ESRI, Bing Mapping Service. 2009

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Figure 1-4
Michie Stadium MRS
DGM Survey Coverage Map
U.S. Army Garrison West Point

Path: Y:\West_Point\mxd\FS\MS_DGM_survey.mxd Author: ricksc 7/12/2012 10:52:56 AM

Legend

- DGM Survey Area
- 3" Stokes Mortar (UXO)
- Cultural Debris
- Frag
- 3" Stokes Mortar Endcap
- 3" Stokes Mortar Tailboom

Imagery Source: ESRI, Bing Mapping Service. 2009

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Figure 1-5
Michie Stadium MRS
Dig Results
U.S. Army Garrison West Point

Path: Y:\West_Point\mxd\FS\MS_Dig_Results.mxd Author: ricksc 11/7/2012 10:18:44 AM

2. APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

CERCLA Section 121 (d)(2)(A) requires that remedial actions meet any federal standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate. CERCLA Section 121 (d)(2)(A)(ii) requires state ARARs to be met if they are more stringent than federal requirements. In addition, the NCP, published in 40 Code of Federal Regulations (CFR) Part 300, requires that local ordinances, unpromulgated criteria, advisories, or guidance that do not meet the definition of ARARs but that may assist in the development of remedial objectives be listed as TBC criteria.

Based on CERCLA guidance, there are three types of ARARs:

- Chemical-specific requirements, which define acceptable exposure concentrations or water quality standards.
- Location-specific requirements, which may restrict remediation activities at sensitive or hazard-prone locations such as active fault zones, wildlife habitats, and floodplains.
- Action-specific requirements, which may control activities and/or technology.

Based on the findings of the RI, only action-specific ARARs and TBCs were evaluated for the Michie Stadium MRS. Action-specific ARARs are usually technology- or activity-based requirements or limitations placed on actions taken with respect to cleanup actions, or requirements to conduct certain actions to address particular circumstances at an MRS.

TBCs are used when there are no ARARs or when ARARs alone may not adequately protect human health and the environment. No TBCs were identified for Michie Stadium MRS.

Action-specific ARARs identified for the Michie Stadium MRS are summarized in **Table 2-1.** The remedial action technologies evaluated do not include on-site treatment, on-site storage (greater than 90 days), or on-site disposal of hazardous waste; therefore, potential ARARs associated with these actions are not identified.

Table 2-1 Applicable or Relevant and Appropriate Requirements and To Be Considered Criteria

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments (Applicable or Relevant and Appropriate, or TBC)
Military Munitions Rule	40 CFR Part 266, Subpart M	Regulates unused munitions, munitions used for intended purposes, and used or fired munitions.	*Applicable* Identify when military munitions become a solid waste; and, if these wastes are also hazardous under this subpart or 40 CFR Part 261, identify the management standards that apply to these wastes.
Division of Water - Classes and Standards of Quality and Purity	6 NYCRR Parts 700 and 703	Establishes water quality standards, including classifications of New York waters and water quality criteria to protect the ground and surface water resources; and controls stormwater and effluent discharges, including toxic substances, into State waters.	*Relevant and Appropriate* For remedial alternatives where soil excavation activities are performed and require stormwater management. Federal guidelines state a minimum of 5,000 square feet of soil excavation before a stormwater management plan would be required.
Hazardous Waste Manifest System and Related Standards For Generators, Transporters and Facilities	6 NYCRR Part 372	Establishes standards for generators and transporters of hazardous waste and standards for generators, transporters, and treatment, storage or disposal facilities relating to the use of the manifest system and its record keeping requirements.	*Applicable* in the event that hazardous waste is generated as part of a remedial alternative; for example, if MEC were removed and would need to be shipped (by a party other than the Army) as hazardous waste.
Waste Transporter Permits	6 NYCRR Part 364	Protects the environment from mishandling and mismanagement of regulated waste transported from the site of generation to the site of ultimate treatment, storage or disposal.	*Applicable* to any off-site transport and disposal of classified hazardous wastes, if generated as part of remedial alternative.

3. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section identifies general response actions and potential MEC detection and removal technologies for the Michie Stadium MRS. The general response actions identified in this section are analyzed in the Development and Screening of Alternatives (Section 4) and the Detailed Analysis of Alternatives (Section 5) of this report. Each technology identified in this section is screened for effectiveness, implementability, and cost to evaluate its viability at the Michie Stadium MRS.

3.1 GENERAL RESPONSE ACTIONS

General response actions are those actions that support the development of remedial alternatives that will achieve the RAO. The following general response actions are considered for the Michie Stadium MRS:

- **No Action**—The No Action alternative is evaluated to satisfy the NCP requirement of 40 CFR 300.430(e)(6), which requires consideration of this alternative as a baseline against which other alternatives may be compared.
- **Risk Management**—Risk Management, which is considered a "limited" action alternative by EPA, includes components of access control and/or public education.
- **MEC Removal**—MEC can be detected and removed from the ground surface and/or below the ground surface. Alternatives for MEC removal include technologies for MEC detection, positioning for the detection technologies, MEC removal, and MEC disposal.

3.2 IDENTIFICATION AND SCREENING OF MEC REMEDIAL TECHNOLOGIES

3.2.1 Screening Criteria

MEC remedial technologies are first evaluated against the three general categories of effectiveness, implementability, and cost to ensure that they meet the minimum standards of the criteria within each category in the FS process. The three general categories are first used to screen the technologies described in Section 3.2.2 and later used to screen the alternatives developed in Section 4. The three general categories are described in the following sections.

3.2.1.1 Effectiveness

In accordance with EPA guidance (EPA, 1988), technologies or alternatives that have been identified should be evaluated further on their effectiveness relative to other processes within the same technology/alternative type. This evaluation should focus on: (1) the potential effectiveness of technology/alternative options in handling the estimated areas or volumes of media and meeting the RAOs; (2) the potential impacts to human health and the environment during the removal or

implementation phase; and (3) how proven and reliable the technology/alternative is with respect to the MEC and conditions at the site.

3.2.1.2 Implementability

Implementability, as a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative, is used during screening to evaluate the combinations of technology/alternative options with respect to conditions at a specific site. Technical feasibility refers to the ability to construct, reliably operate, and meet technology-specific regulations for technology/alternative options until a remedial action is complete. It also includes operation, maintenance, replacement, and monitoring of technical components of a technology/alternative, if required, into the future after the remedial action is complete. Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services and capacity; and the requirements for, and availability of, specific equipment and technical specialists (EPA, 1988).

The determination that a technology/alternative is not technically feasible will usually preclude it from further consideration unless steps can be taken to change the conditions responsible for the determination. Typically, this type of "fatal flaw" will be identified during technology screening, and an alternative consisting of an infeasible technology will not be retained. Negative factors affecting administrative feasibility will normally involve coordination steps to lessen the negative aspects of the technology/alternative but will not necessarily eliminate a technology/alternative from consideration (EPA, 1988).

3.2.1.3 Cost

Typically, technologies/alternatives are defined sufficiently prior to screening so that estimates of cost are available for developing comparisons among technologies/alternatives. However, because uncertainties associated with the definition of technologies/alternatives often remain, it may not be practicable to define the costs of technologies/alternatives with the accuracy desired for the detailed analysis (i.e., +50% to -30%) (EPA, 1988).

According to EPA guidance, a high level of accuracy in cost estimates during screening is not required. The focus should be to make comparative estimates for technologies/alternatives with relative accuracy so that cost decisions among technologies/alternatives will be sustained as the accuracy of cost estimates improves beyond the screening process.

In the detailed analysis in Section 5, which presents an evaluation of the costs of remedial action alternatives, both capital and operation and maintenance (O&M) costs are considered, where appropriate. The evaluation includes the O&M costs that will be incurred for as long as necessary, even after the initial remedial action is complete. In addition, potential future remedial action costs are considered during alternatives evaluation to the extent they can be defined. Present worth analyses are used during the alternatives evaluation to evaluate the expenditures that occur over different time periods. By discounting all costs to a common base year, the costs for different technologies/alternatives can be compared on the basis of a single figure for each alternative. Each cost calculation includes an estimate of the time to complete the proposed alternative.

3.2.2 Evaluation of Technologies

Various technologies and approaches exist for the remediation of MEC. MEC remediation activities include three steps: detection, removal, and disposal. A description of the technologies used in each step is presented in the following subsections. At the end of each subsection, the technologies are screened against the three screening criteria to determine their viability at the Michie Stadium MRS.

3.2.2.1 MEC Detection

MEC detection includes those methods and instruments used to locate surface and subsurface MEC. The best detection method is selected based on the MEC properties such as the depth and size of the suspected UXO and DMM items, and the physical characteristics of the site (i.e., soil type, topography, vegetation, and local geology).

There are two basic forms of MEC detection. The first, visual searching, has been successfully used at a number of sites where MEC is located on the ground surface. When performing a visual search of a site, the area to be searched is typically divided into 5-foot lanes that are systematically inspected for MEC. A metal detector is sometimes used to supplement the visual search in areas where ground vegetation may conceal surface MEC. Typically, any MEC found during these searches is flagged or marked for immediate disposal.

The second form of MEC detection, geophysics, includes various detection instruments designed to locate subsurface MEC and is integrated with the equipment and methods used for location positioning. Each piece of equipment has its own inherent advantages and disadvantages based on its operating characteristics. Thus, selecting the appropriate type of geophysical instrument is critical to the survey success. The instruments designed to locate subsurface MEC include magnetometers and electromagnetic instruments. Positioning technologies include various equipment and instruments that establish geo-

referenced positions for subsurface anomalies detected using MEC detection technologies. The viability of positioning technologies is affected by site conditions, including terrain, tree canopy, and vegetation density.

MEC detection technologies and positioning technologies are described in **Table 3-1** and **Table 3-2**, respectively. **Table 3-1** and **Table 3-2** also include technologies that were tested and used at the Michie Stadium MRS during the RI. The technologies described in **Table 3-1** and **Table 3-2** are screened against the three criteria of effectiveness, implementability, and cost for the Michie Stadium MRS.

Table 3-1 MEC Detection Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Michie Stadium MRS
Visual Searching	**Low - Medium:** Effective for surface removals in open areas with little ground cover. Not appropriate for subsurface removals.	**Medium - High:** Easily implemented by trained UXO qualified and sweep personnel. Minimal to no impacts to cultural or natural resources.	**Low:** Lower than other methods that require detection instrumentation and associated equipment.	NA	Typically supported with a flux-gate magnetometer or frequency-domain electromagnetic induction (FDEMI) metal detector.	**Low:** Most MEC items were found near the surface at the Michie Stadium during the RI, but the amount of ground cover and the difficult terrain reduced visibility.
Flux-Gate Magnetometers: Flux-gate magnetometers measure the vertical component of the geomagnetic field along the axis of the sensor and not the total intensity of the geomagnetic field.	**Medium - High:** Flux-gate magnetometers have been used as the primary detector in traditional mag and dig operations. There is a high industry familiarization. Detects ferrous objects only.	**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.	**Low:** A number of flux-gate magnetometers have a low cost for purchase and operation compared to other detection systems. Lower than other methods on most terrains.	Schonstedt GA-52Cx Schonstedt GA-72Cd Foerster FEREX 4.032 Ebinger MAGNEX 120 LW Vallon EL1202D1 Chicago Steel Tape (Magna-Trak 102)	Analog output not usually co-registered with navigational data.	**Low:** The high ferrous content in the local geology at West Point reduces the effectiveness of magnetometers.
Proton Precession Magnetometers: Proton precession magnetometers measure the total intensity of the geomagnetic field. Multiple sensors are sometimes arranged in proximity to measure horizontal and vertical gradients of the geomagnetic field.	**Medium:** Proton precession systems have similar sensitivities as flux-gate systems, but with a relatively slow sampling rate. There is a high industry familiarization. Detects ferrous objects only.	**Low:** Systems are similar to flux-gate systems in terms of operation and support. Generally is heavier and requires more battery power than flux-gate sensors. Sampling rate is low. Can be used in any traversable terrain. Is widely available from a variety of sources. Minor impacts to cultural or natural resources based on clearing of areas for data collection.	**Medium:** Costs are higher than flux-gate systems because proton precession systems often acquire digital data.	Geometrics G-856AX GEM Systems GSM-19T	Typically used as a base station for other digital magnetometer systems.	**Low:** Proton precession systems are not viable options as a standalone detection system at the Michie Stadium MRS because of low implementability. The high ferrous content in the local geology at West Point reduces the effectiveness of magnetometers.
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).	**High:** This is the industry standard technology to detect MEC using magnetic data analysis. There is a high industry familiarization. Detects ferrous objects only.	**Medium - High:** Equipment is digital, ruggedized, and weather resistant. Common systems weigh more than most flux-gate systems and are affected by heading error. Can be used in most traversable terrain. Widely available from a variety of sources. Processing and interpretation requires trained specialists. Anomaly classification possibilities are limited to 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.	**Medium – High:** Has high purchase cost compared to other technologies. More dependent on terrain than flux-gate magnetometers. Lower costs can be realized when using arrays of multiple detector sensors.	Geometrics G-858 Geometrics G-822 Geometrics G-880 Geometrics G-882 GEM Systems GSMP-40 Scientrex Smart Mag G-tek/GAP TM4	Digital signal should be co-registered with navigational data for best results.	**Low:** The high ferrous content in the local geology at West Point reduces the effectiveness of magnetometers.
Time-Domain Electromagnetic Induction (TDEMI) Metal Detectors: TDEMI is a technology used to induce a pulsed magnetic 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 properties.	**High:** TDEMI technology is the industry standard for MEC detection using electromagnetic data analysis. There is a high industry familiarization. Detects both ferrous and non-ferrous metallic objects. Can be limited by terrain. Geonics EM-EM61-MK2 was tested and proven effective for digital geophysical mapping (DGM) during the Michie Stadium MRS RI.	**Low - Medium:** Sensors are typically larger than digital magnetometers. Can be used in most traversable terrain. Most commonly used instrument and is widely available. Processing and interpretation are relatively straightforward. Anomaly classification possibilities exist for multi-channel systems. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Medium – High:** Has high purchase cost compared to other technologies. Dependent on terrain. Lower costs can be realized when using arrays of multiple detector sensors.	Geonics EM61-MK1 Geonics EM61-MK2 Geonics EM61-MK2 HP Geonics EM61 HH Geonics EM63 Zonge Nanotem G-tek/GAP TM5-EMU Vallon VMH3 Schiebel AN PSS-12	Digital signal should be co-registered with navigational data for best results. Detection depths are highly dependent on coil size and transmitter power.	**Medium:** This technology was proven effective in open and accessible areas at the Michie Stadium MRS during the RI. Because of the development, terrain, and vegetation at the MRS, only a small accessible area of the MRS remains that could be investigated using this technology.

Table 3-1 MEC Detection Technologies (Continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Michie Stadium MRS
Advanced Electromagnetic Induction (EMI) Sensors and Anomaly Classification: Advanced sensors have the ability to precisely capture measurements from enough locations to sample all principal axis responses of an anomaly/item of interest. This provides the necessary information for analysis and classification of hazardous and non-hazardous items.	**Medium – High:** Some sensors may be used in production mode, but most require target locations from previous DGM survey to navigate to for static measurements. Greatest ability of all sensors for the classification of anomalies as either MEC or non-hazardous items. Detects both ferrous and non-ferrous metallic objects.	**Medium:** Most require the use of a vehicle to tow the sensor to the location of an anomaly, although some smaller, man-portable systems are in development. One-meter-wide coil width (or greater) limits accessibility in forested or steeply sloped areas. Advanced analysis is required to effectively use the data acquired by the sensors and accurately classify detected anomalies as MEC or non-hazardous material that will not be removed. Minor to moderate impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High:** Use of the advanced systems often represents additional surveying and processing costs, which may be largely offset by the decrease in the intrusive investigation costs.	ALLTEM Berkeley UXO Discriminator (BUD) BUD Handheld Geometrics MetalMapper Geonics EM63 Man Portable Vector (MPV) TEMTADS TEMTADS 2x2	Sensors have limited industry availability. Requires advanced training for operation, data processing, and analysis.	**Medium:** This technology has been demonstrated and validated by the DoD's Environmental Security Technology Certification Program (ESTCP). The technology would be generally difficult to implement because of the terrain at most of the Michie Stadium MRS. Only the MetalMapper is currently commercially available. All other systems are under development or in testing.
Frequency-Domain Electromagnetic Induction (FDEMI) Metal Detectors: FDEMI sensors generate one or more defined frequencies in a continuous mode of operation.	**Medium - High:** Some digital units have been used as the primary detector in highly ranked systems. Demonstrates capability for detecting small items using handheld units. Is not optimum for detecting deeply buried objects. Lower industry familiarization than time-domain electromagnetic systems. Detects both ferrous and non-ferrous metallic objects. The technology is not good for detecting deeply buried, single items. The White's All-Metals Detector was proven effective during the Michie Stadium MRS RI. The instrument was used effectively for mag and dig surveys.	**High:** Hand-held detectors are generally light and compact. Can be used in any traversable terrain. Most are handheld systems. Widely available from a variety of sources. Minimal to no impacts to cultural or natural resources.	**Medium – High:** Instruments are slow and can detect very small items. Common handheld detectors are much lower cost than digital systems.	Schiebel ANPSS-12 White's All Metals Detector Fisher 1266X Foerster Minex Minelabs Explorer II Geophex GEM 2 Geophex GEM 3 Apex Max-Min	Analog output not usually co-registered with navigational data. Digital output should be co-registered with navigational data	**Medium:** This technology was proven effective at the Michie Stadium MRS during the RI. FDEMI detects all metals, instead of only ferrous items. Because of the development, terrain, and vegetation at the MRS, only a small accessible area of the MRS remains that could be investigated using this technology.
Sub Audio Magnetics (SAM): SAM is a patented methodology by which a total field magnetic sensor is used to simultaneously acquire both magnetic and electromagnetic response of subsurface conductive items.	**Medium - High:** Detects both ferrous and non-ferrous metallic objects. Capable tool for detection of deep MEC. Low industry familiarization. System has seen limited application.	**Low:** High data processing requirements. Available from a few sources. High power requirements. Has longer than average setup times. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High:** Has higher than average operating costs and low availability.	G-tek/GAP SAM	Not commercially available. No established track record.	**Low:** Difficult to implement, high cost, not commercially available.
Magnetometer-Electromagnetic Detection Dual Sensor Systems: These dual sensor systems are expected to be effective in detecting MEC as magnetometers respond to large, deep ferrous targets and TDEMI sensors respond to nonferrous metallic targets.	**High:** Collects co-located magnetic and electromagnetic data to differentiate between ferrous and non-ferrous metallic objects. Has medium industry familiarization.	**Low – Medium:** Increased data processing requirements. Similar terrain constraints to time-domain electromagnetic systems. Available from few sources. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High:** Costs are lower when using a towed array platform. Limited availability.	MSEMS (man-portable EM61-hh & G-822) VSEMS (vehicular EM61-hh & G-822)	Only available from a few sources.	**Low:** Difficult to implement, high cost, only available from a few sources. Towed array is not implementable at the Michie Stadium MRS because of the terrain and vegetation that reduce the accessibility of the system.

Table 3-1 MEC Detection Technologies (Continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Michie Stadium MRS
Airborne Synthetic Aperture Radar (SAR): This airborne method uses strength and travel time of microwave signals that are emitted by a radar antenna and reflected off a distant surface object.	**Low:** Detects both metallic and non-metallic objects. Only detects largest MEC on or near ground surface. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Low:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Minimal to no impacts to cultural or natural resources.	**High:** Aircraft and maintenance costs must be included. Processing costs are higher than other methods.		Few have applied these technologies to detect MEC.	**Low:** Difficult to implement, high cost, only available from a few sources. SAR has not been demonstrated to reliably detect the single MEC items such as those expected to be encountered at the Michie Stadium MRS. Only surface features of interest are detected using this technology because it requires line of sight.
Airborne Laser and Infrared (IR) Sensors: IR and laser technologies can be used to identify objects by measuring their thermal energy signatures. UXO or DMM on or near the soil surface may possess different heat capacities or heat transfer properties than the surrounding soil, and this temperature difference theoretically can be detected and used to identify MEC.	**Low:** Detects both metallic and non-metallic objects. Low industry familiarization. Effectiveness increases when used for wide area assessment in conjunction with other airborne technologies.	**Low:** Requires aircraft and an experienced pilot. Substantial data processing and management requirements. Available from few sources. Minimal to no impacts to cultural or natural resources.	**High:** Aircraft and maintenance costs must be included. Processing costs are higher than other methods.		Few have applied these technologies to detect MEC.	**Low:** Difficult to implement, high cost, only available from a few sources. Airborne laser and IR sensors have not been demonstrated to reliably detect single MEC items such as those expected to be encountered at the Michie Stadium MRS.

Table 3-2 Positioning Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Michie Stadium MRS
Differential Global Positioning System (DGPS): Global Positioning System (GPS) is a worldwide positioning and navigation system that uses a constellation of 29 satellites orbiting the Earth. GPS uses these satellites as reference points to calculate positions on the Earth's surface. Advanced forms of GPS, like DGPS, can provide locations to centimeter accuracy.	**Medium**: Very effective in open areas for both digital mapping and reacquiring anomalies. Very accurate when differentially corrected. Not effective in wooded areas or around large buildings. Commonly achieves accuracy to a few centimeters, but degrades when minimum satellites are available.	**High**: Easy to operate and set up. Requires trained operators. Available from a number of vendors. Better systems are typically ruggedized and very durable. However, significant work time can be lost when insufficient satellites are available because of topography and tree canopy. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Medium**: Requires rover and base station units. Survey control points required for high accuracy results.	Leica GPS 1200 Trimble Model 5800 Thales Ashtech Series 6500	Recommended in open areas.	**Low:** This technology is not effective in wooded areas with tree canopy. Portions of the Michie Stadium are heavily wooded. Because of the development, difficult terrain, and vegetation at the MRS, only a small accessible area remains where this technology could be used.
Robotic Total Station (RTS): RTS is a laser-based survey station that derives its position from survey methodology and includes a servo-operated mechanism that tracks a prism mounted on the geophysical sensor.	**Medium - High**: Effective in open areas for both digital mapping and reacquiring anomalies. Effective around buildings and sparse trees. Is being used in heavily wooded areas with moderate success. Commonly achieves accuracy to a few centimeters.	**Medium**: Relatively easy to operate with trained personnel. Requires existing control. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Low**: Operates as a stand-alone unit. Typically requires survey control points but can be used in a relative coordinate system.	Leica RTS 1100 Trimble Model 5600	Recommended in open areas and in moderately wooded areas. Typically used with TDEMI metal detectors (like Geonics EM61-MK2) and digital magnetometers (like Geometrics G-858).	**Medium:** This technology was used for anomaly reacquisition during the RI. RTS can also be used for data positioning for digital detector systems in moderately wooded areas. Because of the development, difficult terrain, and vegetation at the MRS, only a small accessible area of the MRS remains that could be investigated using this technology.
Fiducial Method: The fiducial method consists of digitally marking a data string with an indicator of a known position. Typically, markers are placed on the ground at known positions (e.g., 25 feet).	**Medium - High**: Medium to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15 to 30 centimeters. The fiducial method was tested and proven effective during the Michie Stadium MRS RI.	**Medium**: Application requires a constant pace and detailed field notes. Can be used anywhere, with varying degrees of complexity in the operational setup. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Low - Medium**: Minimal direct costs associated with this method; however, poor results may negatively impact costs associated with target resolution. Fiducial method requires more "back-end" data processing than some other methods.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable.	**Medium:** This technology was tested and proven effective during the RI. Because of the development, difficult terrain, and vegetation at the MRS, only a small accessible area remains where the fiducial method could be used.
Odometer Method: This method utilizes an odometer that physically measures the distance traveled.	**Medium**: Medium to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15 to 30 centimeters in line and 20 to 80 centimeters on laterals.	**Low**: Setup and operation affected by terrain/environment. Requires detailed field notes and setup times can be lengthy. Can be used anywhere, with varying degrees of complexity in the operational setup. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Low**: Minimal direct costs associated with this method; however, poor results may negatively impact costs associated with target resolution.	NA	Requires very capable operators. Useful method if digital positioning systems are unavailable.	**Low:** Terrain at the MRS would limit effectiveness and implementability.

Table 3-2 Positioning Technologies (Continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Michie Stadium MRS
Acoustic Method: This navigation system utilizes ultrasonic techniques to determine the location of a geophysical instrument each second. It consists of three basic elements: a data pack, up to 15 stationary receivers, and a master control center.	**Low – Medium**: Not very efficient in open areas because of substantial calibration and setup time. Effective in wooded areas although less accurate than other methods. Commonly achieves accuracy of 20 to 50 centimeters.	**Medium**: Difficult to set up and setup requirements are complex. (However, more easily set up and used by trained personnel.) Very little available support. Negatively affected by certain aspects of the environment. Transponders have very limited range, on the order of 75 to 150 feet. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High**: Lengthy setup time can be reduced by using trained personnel. Requires more than one operator. Is expensive to purchase or rent.	USRADS	Requires trained operators. Has been used extensively in wooded areas with success.	**Low**: Technology could be used in wooded areas at the Michie Stadium MRS. High costs limit its viability.
Inertial Navigation: This system measures the acceleration of an object in all three directions and calculates the location relative to a starting point. The starting point is input and periodically refreshed using another navigation system, typically DGPS.	**Low**: Very time consuming with below average accuracy. Accuracy of 4 to 6 centimeters (open area) is commonly achieved shortly after refreshing baseline data, but degrades quickly with time. Required frequency of refreshing baseline significantly reduces production rates.	**Low**: Difficult to operate, limited support. Limited range of use. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**High**: Expensive to purchase or rent. Considerable time associated with refreshing baseline and operation.	Ranger	Still under development.	**Low**: This technology has a low viability at the Michie Stadium MRS because of limited range of use and high costs.

3.2.3 MEC Removal

Removal operations can take the form of a surface-only removal, an intrusive (subsurface) removal, or a combination of the two methods. The decision on the appropriate level of clearance operation is based on the nature and extent of the hazards as well as the current land use and intended future land use of the site.

For a surface removal operation, exposed MEC or suspected hazardous items are identified during the detection phase. The MEC are then inspected, identified, collected (if possible), and transported to a designated area for cataloging and eventual disposal. If it is determined during the inspection that the risk of moving an item is unacceptable, then it may be necessary to destroy the item in place.

Potential subsurface MEC identified by a geophysical survey or other detection methods requires excavation for removal or detonation. Because the actual nature of the buried item cannot be determined without it being uncovered, the evacuation of nonessential personnel is necessary within a predetermined minimum separation distance (MSD). The MSD is based on the munition with the greatest fragmentation distance (MGFD) that may be present within the Michie Stadium MRS. All non-essential personnel and the general public must be evacuated from and maintain their distance beyond the MSD during the intrusive operations. The MSD may be reduced if sufficient engineering controls are implemented. Excavation of the potential MEC takes place with either hand tools or mechanical equipment, depending on the suspected depth of the object. Once an item has been exposed, it is then inspected, identified, collected (if possible), and transported to a designated area for cataloging and disposal. If it is determined during the inspection that the item is MEC and the risk of moving the item is unacceptable, then it may be necessary to destroy the item in place. For intentional detonations, all personnel must observe the MSD. The MSD may be increased or decreased based on the actual item identified. The MSD may also be reduced if appropriate engineering controls are applied.

MEC removal technologies are described in **Table 3-3** and are screened against the three criteria of effectiveness, implementability, and cost for the Michie Stadium MRS.

Table 3-3 MEC Removal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Michie Stadium MRS
Hand Excavation: Technique includes digging individual anomalies using commonly available hand tools.	**Medium - High**: This is the industry standard for MEC removal. It can be very thorough and provides an excellent means of data collection.	**High**: Hand excavation can be accomplished in almost any terrain and climate. Limited only by the number of people available. Minimal to no impacts to cultural or natural resources.	**Average**: Is the standard by which all others are measured.	Probe, trowel, shovel, pick axe.	Locally available and easily replaced tools.	**Medium:** This technology was successfully used during the Michie Stadium MRS RI. Because of the development, difficult terrain, and vegetation at the MRS, only a small accessible area of the MRS remains where a removal action could be performed.
Mechanical Excavation of Individual Anomalies: This method uses commonly available mechanical excavating equipment to support hand excavations.	**Medium - High**: Used in conjunction with hand excavation when soil is too hard causing time delay during hand excavation. Method works well for the excavation of deep single anomalies to remove overburden.	**Low - High**: Equipment can be rented, is easy to operate, and allows excavation of anomalies in hard soil. Access to site may be limited in certain areas by terrain (trees, boulders/rocks). Mechanical excavation is not appropriate for items located on or near the surface because safety standards allow for mechanical excavation only to within 12 inches of a suspected MEC. Moderate impacts to cultural and natural resources because roadways would be constructed and large-scale intrusion would take place to allow equipment into areas.	**Low**: In hard soil, this method has a lower cost than that of having the single anomalies hand excavated.	Tracked mini-excavator or wheeled backhoe. Multiple manufacturers.	Easy to rent and operate.	**Medium:** For deep subsurface anomalies not easily accessible by hand excavation. **Low:** For surface anomalies or shallow subsurface anomalies easily accessible by hand excavation. Because of the development, difficult terrain, and vegetation at the MRS, only small accessible areas of the MRS remain where a removal action could be performed.
Mass Excavation and Sifting: Armored excavation and transportation equipment to protect the operator and equipment from unintentional detonation. Once soil has been excavated and transported to the processing area, it is then processed through a series of screening devices and conveyors to segregate MEC from soil.	**Low**: Process works very well in heavily contaminated areas. Can separate several different sizes of material, allowing for large quantities of soil to be returned with minimal screening for MEC. Heavily contaminated are not anticipated at the Michie Stadium MRS.	**Low**: Earth moving equipment is readily available; however, armoring is not as widely available. Equipment is harder to maintain and may require trained heavy equipment operators. Not feasible for large explosively-configured munitions. Not feasible for heavily wooded areas with numerous ecosystems that must be protected. Major impacts to cultural and natural resources because roadways, stockpiles, and material laydown areas would need to be established for both earth moving and sifting equipment.	**High**: Earth moving equipment is expensive to rent and insure and has the added expense of high maintenance cost.	**Earth Moving Equipment**: Many brands of heavy earth moving equipment, including excavators, off-road dump trucks, and front-end loaders. **Sifting Equipment**: Trommel, shaker, rotary screen from varying manufacturers.	Can be rented and armor can be installed, and equipment delivered almost anywhere. Significant maintenance costs.	**Low:** Technology would not be effective at the Michie Stadium MRS because heavily contaminated areas are not anticipated. Clear cutting at the Michie Stadium MRS would be required to clear heavily wooded areas that would otherwise be inaccessible to the technology and also to establish roadways and material laydown areas that are required for both earth moving and sifting equipment. Technology is costly.
Magnetically Assisted Removal: Magnets are used to separate conductive material from soils.	**Low**: Primarily used in conjunction with mass excavation and sifting operations. Can help remove metal from separated soils, but does not work well enough to eliminate the need to inspect the smaller size soil spoils. Magnetic systems are also potentially useful to help with surface removal of MD and surface debris.	**High**: Magnetic rollers are easily obtained from the sifting equipment distributors and are designed to work with their equipment. Major impacts to cultural and natural resources because roadways, stockpiles and material laydown areas would need to be established for both earthmoving and sifting equipment that support magnetic operations.	**Low**: This method adds very little cost to the already expensive sifting operation.	Magnetic rollers or magnetic pick-ups are available from many manufacturers of the sifting equipment noted above.	Installed by sifting equipment owner.	**Low:** Primarily used in conjunction with mass excavation and sifting operations, which are considered to have a low viability for the Michie Stadium MRS.

Table 3-3 MEC Removal Technologies (Continued)

Remotely Operated Removal Equipment: this equipment has additional control equipment that allows the equipment to be operated remotely.	**Low**: Remotely operated equipment reduces productivity and capability of the equipment. Method is not widely used and is not yet proven to be an efficient means of MEC removal.	**Low**: Uses earth moving equipment, both mini-excavator type and heavier off-road earth moving equipment. Machinery is rigged with hydraulic or electrical controls to be operated remotely. Not feasible for heavily wooded areas with numerous ecosystems that must be protected. Major impacts to cultural and natural resources because roadways, stockpiles, and material laydown areas would need to be established for earth moving equipment.	**High**: Has a combined cost of the base equipment plus the remote operating equipment and an operator. Remote operation protects the operator, but can create high equipment damage costs.	Many tracked excavators, dozers, loaders, and other equipment types have been outfitted with robotic remote controls.	Explosive Ordnance Disposal (EOD) robots are almost exclusively used for military and law enforcement reconnaissance and render-safe operations. They were not evaluated for MEC applications.	**Low:** This technology has a low viability at the Michie Stadium MRS because of low effectiveness and low implementability. Remotely operated removal equipment requires the same earth moving equipment used in mass excavation with the same low implementability because of the heavily wooded terrain.

3.2.3.1 MEC Disposal

MEC disposal technologies are described in **Table 3-4** and screened against the three criteria of effectiveness, implementability, and cost for the Michie Stadium MRS. Treatment technologies for the waste streams generated by MEC disposal technologies are described in **Table 3-5** and screened against the three criteria of effectiveness, implementability, and cost for the Michie Stadium MRS.

3.2.4 Viable Technologies for the Michie Stadium MRS

The technologies listed in **Tables 3-1** to **3-5** that are the most viable options for the Michie Stadium MRS are summarized in **Table 3-6** and are included in the development of remedial alternatives in Section 4. Because of the development, difficult terrain, and vegetation at the MRS, there are limited technologies that are viable options for the Michie Stadium MRS. Technologies summarized in **Table 3-6** are the most viable options, and the majority have been demonstrated to be effective at the Michie Stadium MRS during the RI or at a similar site.

Table 3-4 MEC Disposal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Michie Stadium MRS
Render Safe Procedures (RSP): Procedures that enable the neutralization or disarming of mines and munitions to occur in a recognized and safe manner. RSPs are executed by EOD personnel.	**Low:** Hazardous components may remain intact after procedure. Some procedures may expose hazardous materials inadvertently or intentionally. Lower probability of success compared to other methods. Presents significant danger to performer. No MC or MD-related waste stream generated.	**Low:** Significant personnel exposure in implementation. Specialized tools and equipment commonly are required. Minimal to no impacts to cultural or natural resources.	**Medium – High:** Manpower intensive; specialized tools and equipment.	Manual disassembly, mechanical disassembly, explosive de-armer, cryofracture.	DoD policy allows RSP at MRSs only in cases of extreme emergency. RSPs are not allowed for the mere purpose of rendering a munitions item acceptable to move.	**Low:** The RSP technology is not viable at the Michie Stadium MRS because it can be performed only by EOD personnel and not contractors. Additionally, DoD allows RSP only during emergency situations; therefore, it is unlikely that RSP could be used for the MEC anticipated at Michie Stadium MRS.
Blow-in-Place (BIP): BIP is the destruction of MEC for which the risk of movement beyond the immediate vicinity of discovery is not considered acceptable. Normally, this is accomplished by placing an explosive charge alongside the item.	**High:** Each MEC item is individually destroyed with subsequent results individually verified using quality assurance/quality control (QA/QC). BIP yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**High:** Field-proven techniques, transportable tools, and equipment; suited to most environments. Public exposure can limit viability of this option. Engineering controls can further improve implementation. Major impacts to cultural and natural resources if item cannot be moved away from sensitive cultural or natural resources. Trees and plants could be moved, but cultural resources would not be movable to mitigate impacts. Engineering controls may limit damages to these resources.	**Medium – High:** Manpower intensive. Costs increase in areas of higher population densities or where public access must be monitored/controlled. Limited accessibility to construct engineering controls increases costs.	Electric demolition procedures, non-electric demolition procedures.	Disposition of resultant waste streams must be addressed in BIP operations planning.	**High:** Used for items that are deemed unsafe to move. Technology has been proven effective in similar field conditions.
Consolidated Shots: Consolidated detonations are the collection, configuration, and subsequent destruction by explosive detonation of MEC for which the risk of movement has been determined to be acceptable either within a current working MRS or at an established demolition ground.	**Medium - High:** Limited in use to MEC that are deemed safe to move. BIP yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**Medium – High:** Generally employs the same techniques, tools, and equipment as BIP procedures. Requires larger area and greater controls. Most approved engineering controls are not completely effective/applicable for these operations. Major impacts to cultural and natural resources if item cannot be moved away from sensitive cultural or natural resources. Trees and plants could be moved but cultural resources would not be movable to mitigate impacts. Engineering controls may limit damages to these resources.	**Medium:** Manpower intensive, may require materials handling equipment for large-scale operations.	Electric demolition procedures, non-electric demolition procedures, forklifts and cranes.	Disposition of resultant waste streams must be addressed. Increased areas require additional access and safety considerations.	**Medium:** Only used for MEC that is deemed safe to move. Requires an increase in explosive weight over what would be used for a single explosive demolition shot.
Contained Detonation Chambers (CDCs) – Stationary: CDCs involve destruction of certain types of munitions in a chamber, vessel, or facility designed and constructed specifically for the purpose of containing blast and fragments. CDCs can only be employed for munitions for which the risk of movement has been determined acceptable.	**Low – Medium:** CDCs successfully contain hazardous components. Current literature reviewed shows containment up to 40 pounds (assume net explosive weight (NEW)). Commonly used for fuzes and smaller explosive components. May not be used for larger munitions items found at the Michie Stadium MRS. Limited in use to munitions that are “acceptable to move.” CDCs yield confined releases of MC and MD.	**Low – Medium:** Stationary facilities typically must meet regulatory and construction standards for permanent/semi-permanent waste disposal facilities. Service life and maintenance issues. Such facilities are not commonly used in support of munitions responses. Produce additional hazardous waste streams. Major impacts to cultural and natural resources because roadways and staging areas would need to be established for equipment.	**High:** Siting and construction required. Low feed rates equal more hours on-site. Significant requirements for maintenance of system.	Typically designed on case-by-case basis.	System cleaning and maintenance usually requires personal protective equipment (PPE) and worker training. Probable permitting issues with employment of technology.	**Low:** This technology is not viable for the Michie Stadium MRS because the terrain and vegetation are unsuitable for the siting and construction that would be required. Technology would likely not be effective because the anticipated MEC at the Michie Stadium MRS has a higher explosive weight than the MEC commonly treated by using CDCs.

Table 3-4 MEC Disposal Technologies (Continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Michie Stadium MRS
Contained Detonation Chambers (CDCs) – Mobile: CDCs involve destruction of certain types of munitions in a chamber, vessel, or facility designed and constructed specifically for the purpose of containing blast and fragments. CDCs can only be employed for munitions for which the risk of movement has been determined acceptable.	**Low – Medium:** CDCs successfully contain hazardous components. Current literature reviewed shows containment up to 40 NEW. Commonly used for fuzes and smaller explosive components. May not be used for larger munitions items found at the Michie Stadium MRS. Limited in use to munitions that are "acceptable to move." CDCs yield confined releases of MC and MD.	**Low – Medium:** Designed to be deployed at the project site. Greatly reduced footprint compared to stationary facilities. Service life and maintenance are issues. Requires substantial additional handling and transport of MEC. Requires items to be safe to move. Flashing furnaces have low feed rates because of safety concerns. Produces additional hazardous waste streams. Major impacts to cultural and natural resources because roadways and staging areas would need to be established for equipment.	**Medium – High:** Possible construction require (e.g., berms and pads). Low feed rates equal more hours on-site. Significant requirements for maintenance of system.	Donovan Blast Chamber, Kobe Blast Chamber.	System cleaning and maintenance usually requires PPE and worker training. Probable permitting issues with employment of technology.	**Low:** Technology would likely not be effective because the anticipated MEC at the Michie Stadium MRS has a higher explosive weight than the MEC commonly treated by mobile CDCs. Technology would require clear cutting at the MRS to establish roadways and staging areas for the equipment.
Laser Initiation: Portable (vehicle mounted) lasers are used from a safe distance to heat UXO or DMM lying on the surface, resulting in high or low order detonation of the munitions.	**Low – Medium:** Still in development, although currently deployed overseas for testing. Tests show positive results for 81 millimeter (mm) and below, with reported success on munitions up to 155 mm. Produces low order type effect; subsequent debris still requires disposition. Laser initiation yields unconfined releases of MC and MD, which can be restricted using engineering controls.	**Low:** MEC targets must be exposed/on surface for attack by directed beam. GATOR Laser System (Diode Laser Neutralization via Fiber-Optic Delivered Energy) does not require line-of-sight within approximately 100 meters. GATOR system does require approach and placement of fiber-optic cable at appropriate position of suspected item. Laser systems still addressing power, configuration, transportability, and logistics issues. Major impacts to cultural and natural resources because roadways and staging areas would need to be established for equipment.	**Low – Medium:** Greatly reduced manpower; added equipmen transportability and logistics concerns; no explosives required by syste	ZEUS-HLONS GATOR Laser.	Offers added safety through significant standoff (up to 300 meters). (Note: Acceptable safety standoffs must be evaluated for specific MEC types and location scenarios). ZEUS prototype deployed/employed in Afghanistan (2003).	**Low:** System effectiveness not fully tested. Technology would require clear cutting at the MRS to establish roadways and staging areas for the equipment.

Table 3-5 Waste Stream Treatment Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Michie Stadium MRS
Chemical Decontamination: Uses chemical processes to eliminate all explosives residues from MEC.	**Low – Medium:** Great variety in chemicals required to decontaminate various MEC fillers (e.g., propellants, pyrotechnics, explosives). Difficult to test for effectiveness. May generate additional waste streams (some hazardous).	**Low:** Requires containment of multiple hazardous materials. May require emissions controls. Worker training and PPE typically required. No mobile systems deployable to MRSs exist. Major impacts to cultural and natural resources because roadways and staging areas would need to be established for equipment.	**High:** Specialized manpower, containment requirements, additional waste stream processing.	Supercritical water oxidation. Photocatalysis. Molten salt oxidation.	National Defense Center for Energy and Environment is working on a mobile system, but it treats only scrap metal, not UXO or DMM.	**Low:** System effectiveness not fully tested.
Shredders and Crushers: These technologies use large machines to deform metal components. This results in unusable remnants and overall reduced volume of scrap.	**Low:** Shredders are mainly used to render inert MD as unrecognizable if they still retain the shape of munitions. Limited use to date to shred MEC to make safe. Residue typically still requires additional treatment to achieve higher decontamination levels.	**Low:** Typically stationary facilities. Service life and very high maintenance are expected. Requires additional handling of MEC. Major impacts to cultural and natural resources because roadways and staging areas would need to be established for equipment.	**Medium - High:** Specialized equipment and operators; high maintenance; additional waste stream processing.	Shred Tech ST-100H Roll-Off (vehicle mounted).	Disposition of resultant waste streams must be addressed.	**Low:** The technology would likely not be effective for handling known MEC at the Michie Stadium MRS because the technology is primarily used for MD management. The types of MEC anticipated at the Michie Stadium MRS could not be treated by this method because of explosive weight considerations. However, this technology is a viable option for handling MD.
Thermal Treatment: Decontamination is achieved by exposing debris to high temperatures (between 600 and 1,400 degrees Fahrenheit) for specified periods of time.	**High:** Furnaces are designed to contain hazardous components. Methods are proven means of attaining high degrees (5X) of decontamination. Commonly used to destroy and decontaminate fuzes and smaller explosive components.	**Low:** Typically stationary facilities. Service life and maintenance are issues. Requires additional handling of MEC. Flashing furnaces have low feed rates because of safety concerns. Produces additional hazardous waste streams. Major impacts to cultural and natural resources because roadways and staging areas would need to be established for equipment.	**High:** Possible construction require Low feed rates equal more hours on-site. Maintenance of system.	Rotary kiln incinerator. Explosive waste incinerator. Transportable flashing furnace.	System cleaning and maintenance usually requires PPE and worker training. May require permit to deploy technology.	**Low:** Technology would likely not be effective because the anticipated MEC at the Michie Stadium MRS has a higher explosive weight than the MEC commonly treated by using thermal treatment.
Recycling: Required for MD and non-MD.	**High:** Very effective for MD and non-MD.	**High:** Easily implemented if there is a local metal recycler. No impacts to cultural or natural resources.	**Low – Medium:** Scrap metal may be accepte without cost.	NA		**High:** MD can be sent to the West Point Recycling Center.

Table 3-6 Viable Technologies for the Michie Stadium MRS

MEC Detection		MEC Removal	MEC Disposal	
Geophysical Detection	**Positioning**		**Disposal**	**Waste Stream Treatment**
▪ DGM, including TDEMI metal detector and advanced EMI sensors for anomaly classification. The sensors deemed viable for accessible areas include the EM61-MK2 and TEMTADS 2x2. ▪ Analog (mag and dig), including FDEMI metal detectors. The instrument deemed viable for the Michie Stadium MRS is the White's All-Metals Detector.	▪ Robotic Total Station (with DGM). ▪ Fiducial Method (with DGM).	▪ Hand excavation. ▪ Mechanical excavation to within 12 inches of anomalies followed by hand excavation.	▪ A combination of the following methods, based on MEC evaluation in the field by qualified UXO technicians: – BIP. – Consolidation.	▪ MD and non-MD material recovered from MEC removal and disposal would be sent to the West Point Recycling Center. – MD recovered from MEC disposal would be addressed as appropriate, and treated if necessary, using shredding or crushing.

4. DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, the technologies and general response actions deemed viable for use at the Michie Stadium MRS (see Section 3) are combined to form remedial alternatives. The remedial alternatives are described in this section and are evaluated against the NCP criteria in a detailed analysis that is presented in Section 5.

For remedial alternatives, it should be noted that in cases where levels are above those that allow for unlimited use and unrestricted exposure (40 CFR 300.430(f)(4)(ii), CERCLA requires the review of remedial actions no less than every 5 years to assure that human health and the environment are being protected. Recurring reviews for MEC removal actions determine whether a remedial action continues to minimize explosives safety hazards and continues to be protective of human health, safety, and the environment. Recurring reviews also provide an opportunity to assess the applicability of new technology for addressing previous technical impracticability determinations. Recurring reviews to be completed by West Point would include the following general steps:

- Prepare Recurring Review Plan.
- Establish project delivery team and begin community involvement activities.
- Review existing documentation.
- Identify/review new information and current site conditions.
- Prepare preliminary Site Analysis and Work Plan.
- Conduct site visit.
- Prepare Recurring Review Report.

4.1 ALTERNATIVE 1 – NO ACTION

In Alternative 1, the government would take no action with regard to locating, removing, and disposing of any potential MEC present within the Michie Stadium MRS. In addition, no public awareness or education training would be initiated with regard to the risk of MEC. For the No Action alternative, it is assumed that no change to the current land use of the Michie Stadium MRS (recreational and athletic activities) would occur. If it is determined that the potential exposure and hazards associated with the MRS are compatible with current and future development in the area, as well as the RAO, then the No Action alternative may be selected It is important to note that the government will respond to any future MEC discoveries at the Michie Stadium MRS. The No Action alternative is a potential alternative for the Michie Stadium MRS.

4.2 ALTERNATIVE 2 – RISK MANAGEMENT

Risks related to potential explosives hazards may be managed through a risk management alternative consisting of various access control and/or public awareness components. The implementation of the risk management alternative would provide a means for West Point and its representatives to coordinate an effort to reduce MEC exposure through behavior modification. Alternative 2 – Risk Management can be used in cases where it may not be possible or practical to physically remove MEC from the Michie Stadium MRS or in combination with MEC removal actions if warranted. Successful implementation of risk management is contingent upon the cooperation and active participation of the existing land users and authorities of the U.S. Army and other government agencies to protect the public from explosives hazards.

West Point is willing to participate in risk management. The Baltimore Corps is currently assisting West Point in ongoing Risk Management efforts to educate the installation population and visitors about potential MEC hazards. A Draft Land Use Control Plan (LUCP), which includes the Michie Stadium MRS, was prepared in June 2012 (URS Group, Inc. and ARCADIS/Malcolm Pirnie, 2012). The LUCP is based on an Interim Probability Assessment for Encountering MEC that defines the safety precautions required in the Michie Stadium MRS. The risk management controls recommended for the Michie Stadium MRS, which are consistent with the LUCP, include the following:

- Update Real Property Master Plan.
- Update existing LUCP.
- Review and update Interim Probability Assessment for Encountering MEC.
- Prepare and provide notification during permitting and contracting.
- Prepare and provide brochures/fact sheets.
- Prepare and provide information packages to public officials and emergency management agencies.
- Prepare and provide awareness video.
- Prepare and provide UXO construction support.

4.2.1 Public Advisories

A variety of advisories, notifications, and/or educational materials would be used to alert the public about the potential risks at an MRS. The advisories would be targeted to the groups affected by risk management controls. For instance, advisory pamphlets could be provided to the residents who live in buildings and houses adjacent to or within an MRS, or to crews and individuals when they apply for dig permits or building permits for work adjacent to or within an MRS. Periodic advisories would also be broadcast to all on-post people to ensure that military and civilian personnel, including families, are reminded of the potential presence of MEC and/or MC. These would include:

- Providing information about the potential dangers of MEC and/or MC on post, and notification that any digging on West Point without a permit is a serious offense. Communications may include informational materials such as the 3Rs (Recognize, Retreat, Report) available through various DoD and Army agencies (e.g., see Web sites http://aec.army.mil/usaec/cleanup/mmrp02.html or http://www.denix.osd.mil/uxo/)

- Providing information to on-base residents when they move in, and on an annual basis thereafter.

- Posting articles in the on-post newspaper and/or website on a quarterly or event-specific basis.

4.2.2 Construction Support

The objective of the UXO construction support would be to ensure the safety of workers and the public in the event that MEC items are found during any future construction activities at the Michie Stadium MRS. Construction support would be provided by the U.S. Army Environmental Command (USAEC) for projects executed by USACE. Construction support would be required during intrusive activities. The level of construction support would change in relation to the location and the probability of encountering potential MEC. Based on the RI findings, there is a low probability for encountering MEC and therefore a low potential explosive hazard condition. Based on this assessment of the probability of encountering MEC, construction support would be provided by qualified UXO Technicians either on an on-call basis to respond to MEC that is incidentally encountered or on a standby basis to monitor ongoing construction activities on-site.

4.3 MEC REMOVAL ALTERNATIVES

The UXO item found at the Michie Stadium MRS was recovered at 6 inches bgs, and the MD was recovered between 0 inches and 3 inches bgs. MEC and MD were likely transported to the Michie Stadium MRS in construction fill material that was collected from other areas of West Point. Nearly 70% of the MRS has been developed and includes buildings and structures; impermeable ground surfaces, such as concrete and asphalt roads, parking areas, and walkways; and the playing field within Michie Stadium. The RI field work was conducted in accessible areas of the MRS adjacent to the stadium where the highest use of the area occurs.

Only a portion of the Michie Stadium MRS has not been developed, which includes the area assessed as part of the RI. A portion of this undeveloped area has undergone various earthwork activities, including the capping of the Parking Lot A landfill to the west of the stadium and the construction of Stony Lonesome Road north of the stadium. A 4.3-acre portion of the MRS is applicable for MEC removal

alternatives. The general response action of MEC removal is divided into two remedial alternatives for evaluation:

- Surface Removal of MEC—The removal of MEC detected on the ground surface and breaching the ground surface (Alternative 3).
- Removal of MEC to Detection Depth—The removal of detectable MEC. The depth of detection varies based on the depth of the MEC at the MRS and the detection technology used (Alternative 4).

The MEC removal alternatives include a combination of disposal methods, recycling, and/or waste stream treatment, as listed in **Table 3-6**. Both MEC removal alternatives also include all risk management controls for before, during, and after MEC removal.

4.3.1 Alternative 3 – Surface Removal of MEC with Risk Management

Surface removal of MEC includes removal of MEC detected on the ground surface and breaching the ground surface across 4.3 acres of the Michie Stadium MRS using analog detection instruments such as the White's All-Metals Detector that employs frequency-domain electromagnetic induction (FDEMI) technology. Brush cutting and grubbing would be performed with hand tools where needed to gain accessibility during the surface removal. MEC recovered during the surface removal would be either blown-in-place (BIP) or consolidated for disposal. MD and non-MD would be transferred to the West Point Recycling Center for treatment. The following general tasks would be included in Alternative 3—Surface Removal of MEC:

- Mobilization.
- Survey/positioning.
- Brush clearing and grubbing (where needed).
- MEC detection.
- MEC removal.
- MEC disposal.
- MD and non-MD waste stream treatment.
- Demobilization.

Risk management (including construction support for intrusive activities) would be implemented as described in Alternative 2 in Section 4.2.

4.3.2 Alternative 4 – Removal of MEC to Detection Depth with Risk Management

Alternative 4 includes removal of detected MEC across 4.3 acres using both digital and analog instrumentation. The removal of MEC to detection depth would be performed using digital detection instrumentation such as the EM61-MK2 that employs TDEMI technology and analog detection

instruments such as the White's All-Metals Detector that employs FDEMI technology. Positioning for the digital instrumentation would be conducted using either a robotic total station or the fiducial method. Brush cutting and grubbing would be performed with hand tools where needed to gain accessibility during the surface removal. Anomalies would be reacquired using a robotic total station. MEC recovered during the surface removal would be either BIP or consolidated for disposal. MD and non-MD would be transferred to the West Point Recycling Center for treatment.

Digital instruments would be used to detect MEC in accessible areas of the Michie Stadium MRS. Digital instruments are a less viable option for the remaining portions of the Michie Stadium MRS because of the steep terrain, dense vegetation, and high tree canopy that would reduce the effectiveness of some positioning systems. Based on the screening criteria evaluation results presented in **Table 3-1**, digital instruments would not be employed for areas that are wooded with steep terrain. Analog instruments would be used in the areas of steep terrain and dense vegetation. The following general tasks would be included as part of Alternative 4:

- Mobilization.
- Survey/positioning.
- Brush clearing and grubbing (where needed).
- DGM surveys for MEC detection.
- Digital geophysical data analysis, anomaly selection, and dig list development.
- Anomaly reacquisition.
- Mag and dig surveys for MEC detection.
- MEC removal.
- MEC disposal.
- MD and non-MD waste stream treatment.
- Demobilization.

Risk management (including construction support for intrusive activities) would be implemented as described in Alternative 2 in Section 4.2.

5. DETAILED ANALYSIS OF ALTERNATIVES

The detailed analysis of alternatives consists of the analysis and presentation of the information needed to allow decision-makers to select a site remedy, not the decision-making process itself. During the detailed analysis, each alternative for the Michie Stadium MRS is assessed against the NCP evaluation criteria described in Section 5.1. The results of the detailed analysis are arrayed to compare the alternatives and to identify their strengths and weaknesses. This detailed analysis approach is designed to provide decision-makers sufficient information to adequately compare the alternatives, to select an appropriate remedy for the Michie Stadium MRS, and to demonstrate satisfaction of the CERCLA remedy selection requirements in the Decision Document.

5.1 EVALUATION CRITERIA

Evaluation criteria are described in the NCP, Section 300.430(e)(9). The criteria were developed to address the CERCLA requirements and considerations, and to address the additional technical and policy considerations that are important in selecting remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analyses during the FS and for selecting an appropriate remedial action. The evaluation criteria with the associated statutory considerations are described below.

The "threshold criteria" that each alternative must meet, as described in the NCP, are as follows:

1. **Overall protectiveness of human health and the environment—**Determines whether an alternative achieves the RAOs by eliminating, reducing, or controlling threats to public health and the environment through land use controls, engineering controls, or treatment. The evaluation is based on the three risk factors used in the MEC HA presented in Section 1.3.2.2 of this Michie Stadium MRS FS report: severity, accessibility, and sensitivity. An emphasis is placed on effectiveness in terms of worker safety issues during remedial actions and post-remedial action for local residents and workers based on future land use.

2. **Compliance with ARARs**—Evaluates whether the alternative meets federal and state environmental statutes, regulations, and other requirements that pertain to the site, or whether a waiver is justified. ARARs are summarized in Section 2.

The five "balancing criteria" described below are weighed against each other to determine which remedies are cost effective and are "permanent" to the maximum extent practicable:

3. **Long-term effectiveness and permanence—**Considers the ability of an alternative to maintain protection of human health and the environment over time. The evaluation of the long-term effectiveness and permanence of containment and controls takes into account the magnitude of residual risk/hazard, the adequacy of the alternative in limiting the risk/hazard, the need for long-term monitoring, and the administrative feasibility of maintaining the LUCs and the potential risk/hazard should they fail. The evaluation also considers mechanisms such as the CERCLA

Five-Year Review process to assess on a periodic basis the long-term effectiveness and permanence, as well as the protectiveness, of the alternative.

4. **Reduction of toxicity, mobility, or volume (TMV) of contaminants through treatment—** Considers an alternative's use of treatment to reduce the harmful effects of principal contaminants, their ability to move in the environment, and the amount of contamination present.

5. **Short-term effectiveness—**Considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation. In addition, for MEC, safety considerations include an evaluation of what is available from an administrative standpoint (e.g., access) and what is available from a technical standpoint (e.g., setbacks – are buildings too close for demolition; what will it take to bring the correct resources to the site to mitigate a demolition operation).

6. **Implementability—**Considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services.

7. **Cost—**Includes estimated capital and annual O&M costs, as well as present worth cost. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50% to -30%.

The last two criteria, the "modifying criteria," are usually evaluated following the receipt of comments on the FS, and thus are completed after the Proposed Plan and public comment period on the plan and are presented in the Decision Document:

8. **Regulatory agency acceptance—**Assesses the technical and administrative issues and concerns the state (New York State Department of Environmental Conservation [NYSDEC]) and EPA Region II may have regarding each of the alternatives evaluated in this FS as well as the preferred alternative presented in the Proposed Plan. State and EPA acceptance of an alternative will be evaluated after the Proposed Plan is issued for public comment. Therefore, the regulatory acceptance criterion is not considered in this Michie Stadium MRS FS.

9. **Community acceptance—**Assesses the issues and concerns the public may have regarding each of the alternatives evaluated in this FS as well as the preferred alternative presented in the Proposed Plan. Community acceptance of an alternative will be evaluated after the Proposed Plan is issued for public comment. Therefore, the community acceptance criterion is not considered in this Michie Stadium MRS FS.

5.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

Remedial alternatives are evaluated based on the RI results, including the MEC HA performed for the Michie Stadium MRS.

Based on the RI results, the following remedial alternatives are evaluated for the Michie Stadium MRS against the NCP criteria:

- Alternative 1 – No Action.

- Alternative 2 – Risk Management.
- Alternative 3 – Surface Removal of MEC with Risk Management.
- Alternative 4 – Removal of MEC to Detection Depth with Risk Management.

MEC removal alternatives (Alternatives 3 and 4) are described generally in Section 4.3. Specific remedial alternatives for the Michie Stadium MRS are described in Sections 5.2.1.1 through 5.2.1.4.

5.2.1 Michie Stadium MRS

The Michie Stadium MRS is 14.1 acres and is located in the Main Post area of West Point. A total of 0.43 acre of the Michie Stadium MRS was investigated using electromagnetic DGM surveys to delineate the nature and extent of MEC. One MEC item (UXO, mortar, 3-inch Stokes, MKI, unfuzed) and seven MD items were recovered during intrusive investigations. The MD items included one tail boom and one end cap from 3-inch Stokes mortars and five fragments from unknown munitions. Fourteen 3-inch MKI Stokes mortars were found in 2001 and 2003 during seismic upgrades of the west stands and construction of Randall Hall.

Nearly 70% of the Michie Stadium MRS has been developed and includes buildings and structures; impermeable ground surfaces, such as concrete and asphalt roads, parking areas, and walkways; and the playing field within Michie Stadium. The RI field work was conducted in the accessible areas of the MRS adjacent to the stadium where the highest use of the area occurs. A 4.3-acre portion of the MRS has not been developed, including the area assessed as part of the RI. The majority of this undeveloped area has undergone earthwork activities, including the capping of the Parking Lot A landfill to the west of the stadium and the construction of Stony Lonesome Road north of the stadium.

A Draft LUCP, which includes the Michie Stadium MRS, was prepared in June 2012. The LUCP is based on an Interim Probability Assessment for Encountering MEC that defines the safety precautions required in the Michie Stadium MRS. The LUCP establishes restrictions for excavation at the MRS. Dig permits and notations in the West Point Master Plan are used to enforce these restrictions.

Based on the MEC HA, the Michie Stadium MRS has a Hazard Level Category 4, which indicates the MRS has a low potential explosive hazard condition. The presence of MEC at an MRS means that an explosive hazard may exist; therefore, MEC may continue to pose a hazard at a Hazard Level 4 MRS. The MRS has a low number of contact hours by the public and workers (maintenance personnel). The remedial alternatives evaluated for the Michie Stadium MRS are presented in the following subsections.

5.2.1.1 Alternative 1 – No Action

The No Action alternative for the Michie Stadium MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment**—The Michie Stadium MRS was determined to have a low hazard potential because of the presence of MEC in the shallow subsurface. The MRS has a low number of contact hours by the public and workers (maintenance personnel). Alternative 1 would not eliminate, reduce, or control the threat of human or biological receptor exposure to MEC on the ground surface or in the subsurface. A MEC HA was conducted for each alternative and is provided in **Appendix B**. The MEC HA scoring for Alternative 1 is a Hazard Level 4 with a score of 525. This is consistent with the RI MEC HA presented in Section 1.3.2.2 of this Michie Stadium MRS FS.

2. **Compliance with ARARs**—There are no action-specific ARARs associated with Alternative 1 because there are no active remedial actions associated with this alternative.

3. **Long-Term Effectiveness and Permanence**—The magnitude of risk is not expected to be significantly reduced over the long term based on intended future land use. Alternative 1 requires no technical components and poses no uncertainties regarding its performance. Site reviews would be conducted once every 5 years as required by CERCLA to assess the MRS condition and the degree of protectiveness to human health and the environment.

4. **Reduction of TMV of Contaminants Through Treatment**—Alternative 1 would not reduce MEC volume or mobility because of human interaction or natural processes; however, it is anticipated that the remaining MEC volume is low.

5. **Short-Term Effectiveness**—There would be no additional risk to the community or workers because there are no construction or operation activities associated with Alternative 1.

6. **Implementability**—The implementation of Alternative 1 would pose no technical difficulties. Alternative 1 would be administratively feasible because it requires minimal contact or coordination with agencies to implement.

7. **Cost**—Because there is no action associated with Alternative 1, the total present-worth cost to perform Alternative 1 is $0.

5.2.1.2 Alternative 2 – Risk Management

Alternative 2 – Risk Management for the Michie Stadium MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment**—The Michie Stadium MRS was determined to have a low hazard because of the MEC recovered in the shallow subsurface during the RI and previous construction activities. No MEC was observed on the ground surface during the RI. The MRS has a low number of contact hours by the public and workers (maintenance personnel). The institutional controls components of risk management recommended in this Michie Stadium MRS FS and presented in the LUCP would raise public awareness and modify public behavior during excavation activities performed in the MRS, thus

increasing protection of human health. Alternative 2 would eliminate, reduce, or control threats to address the low hazard for human and biological receptor exposure to potential surface and subsurface MEC by providing construction support during excavation activities. Alternative 2 would be protective of the environment because no clearing, grubbing, or excavation would be required. The MEC HA scoring for Alternative 2 is a Hazard Level 4 with a score of 425.

2. **Compliance with ARARs**—There are no action-specific ARARs associated with Alternative 2, unless an item is identified during construction support. If a MEC item is identified, then 40 CFR Part 266, Subpart M would be applicable. If an item needs to be transported, then 6 NYCRR Part 372 and 6 NYCRR Part 364 would be applicable, and procedures to comply with these regulations would be followed.

3. **Long-Term Effectiveness and Permanence**—Alternative 2 is contingent upon the cooperation and active participation of the existing powers and authorities of government agencies. The remedial design will specify the steps and controls to be put in place, such as requiring dig permits and making notations in the Master Plan that will ensure that the risk management controls are maintained. The components of risk management that are recommended, as described in Section 4.2, include printed media such as brochures and fact sheets, and audio/video media. Maintaining the LUCs in the long term is administratively feasible because LUCs are already implemented and maintained across West Point. If the risk management controls fail, there would be a potential risk of an explosive hazard; however, the risk of an explosive hazard is considered unlikely because of the low probability of encountering MEC. For consistency with the Draft LUCP, an annual review of the Michie Stadium MRS would be conducted to ensure that LUCs remain effective and that the land use has not changed. Reviews would also be conducted once every 5 years as required by CERCLA to assess the site condition and the degree of protectiveness to human health and the environment.

4. **Reduction of TMV of Contaminants Through Treatment**— Alternative 2 would reduce the toxicity and volume of MEC in those instances where MEC is detected, recovered, and disposed of during construction support, including future building construction. Mobility would be only slightly reduced as a result of restrictions in human to MEC interaction, but natural processes would still occur. Alternative 2 does not satisfy the statutory preference for treatment as a principal element of the remedy.

5. **Short-Term Effectiveness**—There would be no additional risk to the community or workers because there are no construction or operation activities associated with Alternative 2.

6. **Implementability**—West Point is willing to participate in risk management, and a Draft LUCP, which includes the Michie Stadium MRS, was prepared in June 2012. Once legal mechanisms are in place for the LUCP, they can be implemented for Alternative 2. The majority of the components recommended in Alternative 2 can be readily implemented because there are no technical difficulties associated with this alternative and the materials and services needed to implement this alternative are available. Printed media and audio/video media can be developed and disseminated.

7. **Cost**—The total present-worth cost to perform Alternative 2 at the Michie Stadium MRS is $181,998. This cost has been rounded to the nearest thousand dollars. Detailed cost estimates for Alternative 2 are provided in **Appendix A**.

5.2.1.3 Alternative 3 – Surface Removal of MEC with Risk Management

Alternative 3 – Surface Removal of MEC with Risk Management for the Michie Stadium MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment**—The Michie Stadium MRS was determined to have a low hazard potential because of the MEC recovered in the shallow subsurface during the RI and previous construction activities. The MRS has low contact hours by the public and workers (maintenance personnel). The UXO, a 3-inch Stokes mortar, MK I was found at 6 inches bgs during the RI. No MEC was observed on the ground surface during the RI. MD was found between 0 inches and 3 inches bgs. MEC surface removal activities would remove only MEC that is visible on the ground surface. Potential MEC remaining within the Michie Stadium MRS would likely be in the subsurface. Approximately 70% of the MRS has been developed and is covered by impermeable surfaces such as buildings, roads, and parking lots. Only 4.3 acres of the Michie Stadium MRS are undeveloped but have undergone earthwork activities, thus removing or covering potential MEC; therefore, a MEC surface removal would not eliminate, reduce, or control threats to protection of human health.

   MEC surface removal activities would not be protective of the environment because they require some clearing and grubbing and possible excavation at the Michie Stadium MRS. MEC that is not acceptable to move would be BIP. Consolidation is an efficient method of disposal for MEC that is acceptable to move. BIP demolition results in a less confined waste stream than consolidation and is, therefore, less protective of human health and the environment.

   Demolition activities may also negatively impact cultural resources that cannot be moved. The waste stream could be reduced and protectiveness could be increased through the use of appropriate engineering controls. Engineering controls could also reduce impacts to cultural resources. Only 4.3 acres of the Michie Stadium MRS are undeveloped but have undergone earthwork activities, thus removing or covering potential MEC. A MEC surface removal would provide protection to human health by eliminating, reducing, or controlling threats to only the portions of the MRS that have not been developed and are available for a removal action. Threats to human health associated with the future building construction would be reduced by the removal of surface MEC items and would be controlled through the implementation of risk management controls. The MEC HA scoring for Alternative 3 is a Hazard Level 4 with a score of 335. The MEC HA does not account for Minimum MEC Depth Relative to Maximum Intrusive Depth when evaluating Alternative 3 because MEC is located only in the subsurface and the intrusive depth does not overlap with the minimum MEC depth.

2. **Compliance with ARARs**—Surface removal of MEC would be performed to comply with all ARARs, including DoD and EPA guidance. Risk management would be implemented to comply with ARARs, as discussed in Alternative 2. This work would be conducted in a manner that would cause minimal to no impacts to cultural resources such as Michie Stadium and the surrounding infrastructure. If a MEC item is identified during the surface removal action or construction support, then 40 CFR Part 266, Subpart M would be applicable. If an item needs to be transported, then 6 NYCRR Part 372 and 6 NYCRR Part 364 would be applicable. 6 NYCRR Parts 700 and 703 would be relevant and appropriate only if soil excavation areas exceed 5,000 square feet, in which case stormwater management practices would be implemented. Procedures for following these regulations would be developed in the Remedial Design Work Plans.

3. **Long-Term Effectiveness and Permanence**—Surface removal of MEC would not provide long-term effectiveness because potential remaining MEC would likely be in the subsurface. MEC below the ground surface would remain in the Michie Stadium MRS and could move to the surface because of erosion or frost heave or human interaction. Risk management would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the removal activity. Alternative 3 would provide long-term effectiveness and permanence during the construction of future buildings by the removal of surface MEC items and by the implementation of risk management controls.

4. **Reduction of TMV of Contaminants Through Treatment**—Surface removal would not reduce the number (or volume) of explosives hazards because MEC, if present, is likely below the ground surface. The mobility of MEC deeper than ground surface that could occur as a result of erosion or frost heave would not be reduced by a surface removal. Risk management would not reduce the volume or mobility of potential MEC in the area. To the extent that MEC is detected, recovered, and disposed of, its ability to move is reduced. MEC remaining after a removal activity would maintain its ability to move, based on the physical processes described above. Alternative 3 satisfies the statutory preference for treatment as a principal element of the remedy because surface MEC would be removed and destroyed.

5. **Short-Term Effectiveness**—While the removal action is being conducted, there would be an increase in risk to workers because of the hazards associated with MEC. The increased risk to the public during the removal action would be mitigated, where possible, by the use of engineering controls and/or evacuations to maintain MSDs. The risk to workers and to the public associated with MEC that needs to be BIP would be greater than the risk associated with the items that are acceptable to move and can be consolidated. It is more difficult to control the area around an item's location than it would be to move an item to a secure location. Items that are acceptable to move can be disposed of in a more controlled environment at a secure location. The risk to the public during the disposal can be mitigated, where possible, by the use of engineering controls and/or evacuations to maintain MSDs. Risk management would not increase risk to workers or the public, unless an item was identified during construction support, as described in Alternative 2.

6. **Implementability**—Surface removal of MEC is technically and administratively feasible and can be implemented at the Michie Stadium MRS, as shown during the RI. Specific procedures would need to be developed to manage/minimize impacts to cultural resources and public transportation routes, such as establishing traffic flow patterns during intrusive investigations where traffic would be impacted by exclusion zones. Significant coordination and evacuation would be required to minimize impacts to West Point personnel and contractors working in the MRS. When working near cultural resource locations, the West Point Cultural Resources Manager would mark the locations of the cultural sites on the ground and a 50-foot buffer would be maintained. No project activities would be conducted within the marked 50-foot buffer. Additionally, the provisions of SOP 16-1: Protection of Archaeological or Historical Artifacts (U.S. Military Academy (USMA), 1995) would be followed. This procedure was implemented successfully during the RI. Regarding MEC disposal, BIP is more difficult to implement than consolidation because it is more difficult to control the area around an item. It may also be more difficult to transport engineering controls to the MEC for BIP demolition than to a consolidation area that may be more secure and accessible. Materials and services to perform Alternative 3 are readily available. Risk management would be implemented as described in Alternative 2.

7. **Cost**—The total present-worth cost to perform Alternative 3 at the Michie Stadium MRS is $581,139. Detailed cost estimates for Alternative 3 are provided in **Appendix A**.

5.2.1.4 Alternative 4 – Removal of MEC to Detection Depth with Risk Management

Alternative 4 – Removal of MEC to Detection Depth with Risk Management is evaluated relative to the NCP criteria for the Michie Stadium MRS as follows:

1. **Overall Protectiveness of Human Health and the Environment**—The Michie Stadium MRS was determined to have a low hazard potential because of the MEC recovered in the shallow subsurface during the RI and previous construction activities. The UXO, a 3-inch Stokes mortar, MK I, was found at 6 inches bgs during the RI. No MEC was observed on the ground surface during the RI. MD was found between 0 inches and 3 inches bgs. Potential MEC remaining within the Michie Stadium MRS would likely be in the subsurface. Approximately 70% of the Michie Stadium MRS has been developed and is covered by impermeable surfaces such as buildings, roads, and parking lots. Only 4.3 acres of the MRS are undeveloped but have undergone earthwork activities, thus removing or covering potential MEC; therefore, removal of MEC to detection depth would eliminate the risk related to detectable MEC below the ground surface and provide improved protection for human health. Removal activities for MEC would not be protective of the environment because they would require clearing and grubbing and excavation at the location where the anomalies are detected. MEC that is not acceptable to move would be BIP. Consolidation is an efficient method of disposal for MEC that is acceptable to move. BIP results in a less confined waste stream than consolidation and is, therefore, less protective of human health and the environment.

   Demolition activities may also negatively impact cultural resources that cannot be moved. The waste stream could be reduced and protectiveness could be increased through the use of appropriate engineering controls. Engineering controls could also reduce impacts to cultural resources. Risk management would provide additional protection to human health, as discussed in Alternative 2. Threats to human health associated with the future building construction would be reduced by the removal of surface and subsurface MEC items and would be controlled through the implementation of risk management controls. The MEC HA scoring for Alternative 4 is a Hazard Level 4 with a score of 345.

2. **Compliance with ARARs**—Removal of MEC to detection depth would be performed to comply with all ARARs, including DoD and EPA guidance. Risk management would be implemented to comply with ARARs, as discussed in Alternative 2. This work would be conducted in a manner that would cause minimal to no impacts to cultural resources such as Michie Stadium and the surrounding infrastructure. If a MEC item is identified during the removal action or construction support, then 40 CFR Part 266, Subpart M would be applicable. If an item needs to be transported, then 6 NYCRR Part 372 and 6 NYCRR Part 364 would be applicable. 6 NYCRR Parts 700 and 703 would be relevant and appropriate only if soil excavation areas exceed 5,000 square feet, in which case stormwater management practices would be implemented. Procedures for following these regulations would be developed in the Remedial Design Work Plans.

3. **Long-Term Effectiveness and Permanence**—Removal of MEC to detection depth would provide long-term effectiveness by permanently removing the remaining detectable MEC from the Michie Stadium MRS. MEC removal work would be performed only in undeveloped areas, and MEC in developed areas would remain in the MRS. Risk management would provide additional long-term effectiveness and permanence by assisting in managing risk before, during,

and after the removal activity. Because of the removal of remaining detectable MEC and the provision of risk management processes, including construction support, this alternative would provide long-term effectiveness and permanence during the construction of future buildings. Risk management is described in Alternative 2.

4. **Reduction of TMV of Contaminants Through Treatment**—Removal and disposal of MEC to detection depth would reduce the number of explosives hazards by up to 100% in areas that are not developed and greatly reduce the volume of MEC. To the extent that MEC is detected, recovered, and disposed of, its ability to move is reduced. MEC remaining after a removal activity would maintain its ability to move because of natural processes such as soil erosion and frost heave. Alternative 4 would reduce the volume and toxicity of MEC for future construction projects by removing MEC to detection depth. Alternative 4 satisfies the statutory preference for treatment as a principal element of the remedy because surface and subsurface MEC would be removed and destroyed.

5. **Short-Term Effectiveness**—While the removal action is conducted, there would be an increase in risk to workers because of the hazards associated with MEC. The increased risk to the public during the removal action would be mitigated, where possible, by the use of engineering controls and/or evacuations to maintain MSDs. There would be no increased risk to workers or the public due to Risk Management, as described in Alternative 2.The risk to workers and to the public associated with MEC that needs to be BIP would be greater than the risk associated with items that are acceptable to move and can be consolidated. It is more difficult to control the area around an item's location than it would be to move an item to a secure location. Items that are acceptable to move can be disposed of in a more controlled environment at a secure location. The risk to the public during the disposal can be mitigated, where possible, by the use of engineering controls and/or evacuations to maintain MSDs.

6. **Implementability**—Specific procedures would need to be developed to manage/ minimize impacts to cultural resources and public transportation routes, such as establishing traffic flow patterns during intrusive investigations where traffic would be impacted by exclusion zones. Specific procedures would need to be developed to manage/minimize impacts to cultural resources and public transportation routes, such as a traffic management plan being developed to establish traffic flow patterns during intrusive investigations where traffic would be impacted by exclusion zones. Significant coordination and evacuation would be required to minimize impacts to West Point personnel and contractors working in the Michie Stadium MRS. When working near cultural resource locations, the West Point Cultural Resources Manager would mark the locations of the cultural sites on the ground and a 50-foot buffer would be maintained. No project activities would be conducted within the marked 50-foot buffer. Additionally, the provisions of SOP 16-1: Protection of Archaeological or Historical Artifacts (USMA, 1995) would be followed. This procedure was implemented successfully during the RI. Regarding MEC disposal, BIP demolition is more difficult to implement than consolidation because it is more difficult to control the area around an item. It may also be more difficult to transport engineering controls to the MEC for BIP demolition than to a consolidation area that may be more secure and accessible. Materials and services to perform Alternative 4 are readily available. Risk management would be implemented as described in Alternative 2.

7. **Cost**—The total present-worth cost to perform Alternative 4 at the Michie Stadium MRS is $737,574. Detailed cost estimates for Alternative 4 are provided in **Appendix A**.

5.3 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Based on the detailed analysis of remedial alternatives in Section 5.2, the strengths and weaknesses of the remedial alternatives relative to one another are evaluated with respect to each of the NCP criteria. Alternatives 1 through 4 are compared for the Michie Stadium MRS in the discussions below.

1. **Overall Protectiveness of Human Health and the Environment**—The UXO, a 3-inch Stokes mortar, MK I, was found at 6 inches bgs during the Michie Stadium RI. MD was found between 0 inches and 3 inches bgs. No MEC was observed on the ground surface during the RI. Alternative 1 is not protective because no action would be taken to prevent human exposure to MEC. Alternative 2 is more protective than Alternative 1 because risk management would reduce unacceptable exposure. Alternative 3 does not provide any additional protectiveness over Alternative 2 because the potential remaining MEC is in the subsurface. Alternative 4 is more protective because it would remove subsurface MEC; however, the probability of encountering additional MEC at the Michie Stadium MRS is low, and Alternative 2 and Alternative 3 include risk management to reduce exposure to the potential remaining hazards. Alternatives 2, 3, and 4 fall within the same MEC HA Hazard Level Category (Category 4), meaning that they have a low risk of explosive hazard because of the controls established as part of the risk management included for each alternative. Because risk management lowers the explosive hazard risk, the overall protectiveness is increased for each alternative. Alternative 3 has a MEC HA score of 335, indicating slightly greater protection than Alternatives 1, 2, and 4; however, the MEC HA for Alternative 3 does not include the Minimum MEC Depth Relative to Maximum Intrusive Depth subsurface score. In actuality, Alternative 4 is the most protective option because it does include the subsurface scoring. In each of the three alternatives, controls established as part of risk management provide protectiveness.

2. **Compliance with ARARs**—There are no regulations or criteria associated with Alternative 1, and Alternatives 2 through 4 would be implemented and performed to comply with all ARARs. Alternative 4 would be more intrusive in nature and would require further attention to impacts on cultural resources.

3. **Long-Term Effectiveness and Permanence**—Alternative 1 is not effective or permanent. Alternative 2 is more effective and permanent than Alternative 1, assuming the cooperation and active participation of the existing powers and authorities of government agencies. Risk management would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after site activities. Surface removals for Alternative 3 would not be effective because the potential remaining MEC is in the subsurface. Alternative 4 would be more effective and more permanent than Alternative 2 because MEC would be removed permanently from the Michie Stadium MRS. Alternative 4 would be the most effective and permanent alternative because detectable MEC, including items in the subsurface, would be removed permanently.

4. **Reduction of TMV of Contaminants Through Treatment**— Alternative 1 would not reduce the TMV of MEC at the Michie Stadium MRS. Alternative 2 would be effective in the reduction of TMV, but only to the extent that MEC is detected, recovered, and disposed of during future construction activities. Alternative 3 would be somewhat effective in the reduction of TMV, but only to the extent that surface MEC is present, detected, recovered, and destroyed. Subsurface MEC remaining after implementation of Alternative 3 would maintain its ability to move because of natural processes. Alternative 4 would be effective in reducing the TMV of MEC because all

detectable surface and subsurface MEC would be removed. Alternatives 3 and 4 satisfy the statutory preference for treatment as a principal element of the remedy because MEC would be removed and destroyed. Alternative 3 and Alternative 4 would also reduce the toxicity and volume of MEC in those instances where MEC is removed and destroyed during future construction projects.

5. **Short-Term Effectiveness**—Because no construction activities are associated with either alternative, Alternatives 1 and 2 would not present significant additional risk to the public or to workers at the Michie Stadium MRS. Alternatives 3 and 4 would increase risk to the public and to workers during removal of MEC. Increased risk to the public during the removal of MEC would be reduced by the use of engineering controls and/or evacuations to maintain MSDs. Alternatives 1 and 2 would not cause damage to the environment because no clearing, grubbing, or excavation would be required. Alternatives 3 and 4 would cause damage to the environment because of these activities. Alternative 4 would cause greater damage to the environment than Alternative 3 as a result of the larger scale of excavation required.

6. **Implementability**—Alternative 1 would be easily implemented because it requires no action. The risk management activities recommended as Alternative 2 could also be readily implemented because these activities pose no technical difficulties and the materials and services needed are available. Removals of MEC to various depths, similar to those proposed in Alternatives 3 and 4, were implemented effectively at the Michie Stadium MRS during the RI; however, these alternatives are more difficult to implement than Alternative 2. Alternative 4 would take longer to implement as it would be performed over a large area and would require intrusive work to instrument detection depth. Specific activities, including awareness training and mitigation activities, would be required to protect cultural resources. Alternative 4 would be slightly more difficult to implement because of the additional administrative work required as a result of the length of the removal action compared to Alternative 3.

7. **Cost—**The total present-worth cost to perform each alternative is as follows:

   - Alternative 1 = $0
   - Alternative 2 = $181,998
   - Alternative 3 = $581,139
   - Alternative 4 = $737,574

   Note: Costs have been rounded to the nearest thousand dollars.

5.4 RECOMMENDED REMEDIAL ACTION ALTERNATIVE

Table 5-1 presents a summary of the detailed analysis of the alternatives for the Michie Stadium MRS. Alternative 2 - Risk Management is the recommended remedial action alternative. Alternative 2 was ranked more favorably than Alternatives 1, 3, and 4. Alternative 2 has more criteria ranked as favorable in the detailed analyses. Alternative 2 can be readily implemented and would provide a high level of protectiveness over the long-term compared to its cost, whereas Alternatives 3 and 4 are slightly more difficult to implement and would incur a much greater cost for only a slightly higher level of protectiveness over the long term. Alternative 2 was selected because it ranked favorably in the detailed analysis over other alternatives in relation to the overall protectiveness of human health and the environment, compliance with ARARs, and implementability.

Table 5-1 Summary of Detailed Analysis of Remaining Alternatives

	Screening Criterion	Alternative 1: No Action	Alternative 2: Risk Management	Alternative 3: Surface Removal with Risk Management	Alternative 4: Subsurface Removal to Instrument Detection Depth with Risk Management
Threshold	Overall Protection of Human Health and Environment	○	●	●	●
	Compliance with ARARs	○	●	●	●
Balancing	Long-Term Effectiveness	○	●	●	●
	Reduction of Toxicity, Mobility and Volume through Treatment	○	○	◑	●
	Short-Term Effectiveness	●	●	◑	◑
	Implementability	●	●	◑	◑
	-Technical Feasibility	●	●	●	●
	-Administrative Feasibility	●	●	◑	◑
	-Availability of Materials and Services	●	●	●	●
	Cost[1]	$0	$181,998	$581,139	$737,574
Modifying[2]	Regulatory Agency Acceptance	TBD	TBD	TBD	TBD
	Community Acceptance	TBD	TBD	TBD	TBD

● - Favorable (Yes for threshold criteria)
◑ - Moderately Favorable
○ - Not Favorable (No for threshold criteria)

[1] Costs are detailed in Appendix A.
[2] The modifying criteria of regulatory agency and community acceptance are to be determined (TBD) following review and input from these parties.

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APPENDIX A

COST ESTIMATES

Feasibility Study Cost Estimate
Michie Stadium MRS
US Army Garrison West Point

MRS #	MRS Description	Acreage	Alternative 1	Alternative 2	Alternative 3	Alternative 4
			No Action	Risk Management	Surface Removal of MEC with Risk Management	Surface Removal of MEC to Detection Depth with Risk Management
1	Michie Stadium	14.40	$0	$181,998	$581,139	$737,574
TOTALS			**$0**	**$181,998**	**$581,139**	**$737,574**

Michie Stadium MRS
Alternative No: 1
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	99,000	$0
0110	Explosives Safety Submission	0.00	LS	N/A	N/A	N/A	38,500	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	57,865	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	20,985	$0
0310	Survey/Positioning	0.00	AC	0.0	0.0	0.0	15,522	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	11,090	$0
0400	MEC Surface Removal	0.00	AC	0.0	0.0	0.0	42,304	$0
0410	MEC Removal to Detection Depth (M&D)	0.00	AC	0.0	0.0	0.0	42,689	$0
0420	Digital Geophysical Mapping	0.00	AC	0.0	0.0	0.0	20,932	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	18,714	$0
0440	Anomaly Reacquisition	0.00	AC	0.0	0.0	0.0	4,965	$0
0450	MEC Subsurface Removal (DGM)	0.00	AC	0.0	0.0	0.0	42,689	$0
0500	MEC Disposal	0.00	WEEKS	0.0	0.0	0.0	38,266	$0
0510	Scrap Disposal	0.00	WEEKS	0.0	0.0	0.0	19,568	$0
0600	Site Restoration	0.00	AC	0.0	0.0	0.0	40,819	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	12,925	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	77,000	$0
0800	Risk Management	0.00	LS	N/A	N/A	N/A	42,350	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design	8%						$0
	Construction Management	6%						$0
	Total Capital Cost							**$0**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0900	Risk Management - Annual Cost	5 - 30	0	LS	1,265	$0
1000	Five Year Review - First Review	5	0	EA	8,800	$0
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	0	EA	5,500	$0
1100	Four to Five Year UXO Construction Support	5 - 30	0	EA	26,769	$0

PRESENT VALUE ANALYSIS:

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
Capital Cost	0	$0	$0	1	$0
Periodic Cost	5	$0	$0	0.854	$0
Periodic Cost	10	$0	$0	0.737	$0
Periodic Cost	15	$0	$0	0.633	$0
Periodic Cost	20	$0	$0	0.543	$0
Periodic Cost	25	$0	$0	0.467	$0
Periodic Cost	30	$0	$0	0.400	$0
		$0			$0
Total Present Value of Alternative					**$0**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Michie Stadium MRS
Alternative No: 2
Risk Management

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.50	LS	N/A	N/A	N/A	99,000	$49,500
0110	Explosives Safety Submission	0.50	LS	N/A	N/A	N/A	38,500	$19,250
0200	Mobilization	0.00	LS	N/A	N/A	N/A	57,865	$0
0300	Site Management	0.00	WEEKS	0.0	0.0	0.0	20,985	$0
0310	Survey/Positioning	0.00	AC	0.0	0.0	0.0	15,522	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	11,090	$0
0400	MEC Surface Removal	0.00	AC	0.0	0.0	0.0	42,304	$0
0410	MEC Removal to Detection Depth (M&D)	0.00	AC	0.0	0.0	0.0	42,689	$0
0420	Digital Geophysical Mapping	0.00	AC	0.0	0.0	0.0	20,932	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	18,714	$0
0440	Anomaly Reacquisition	0.00	AC	0.0	0.0	0.0	4,965	$0
0450	MEC Subsurface Removal (DGM)	0.00	AC	0.0	0.0	0.0	42,689	$0
0500	MEC Disposal	0.00	WEEKS	0.0	0.0	0.0	38,266	$0
0510	Scrap Disposal	0.00	WEEKS	0.0	0.0	0.0	19,568	$0
0600	Site Restoration	0.00	AC	0.0	0.0	0.0	40,819	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	12,925	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	77,000	$0
0800	Risk Management	1.00	LS	N/A	N/A	N/A	42,350	$42,350
	Sub-Total							$111,100
	Contingency	15%						$16,665
	Sub-Total							$127,765
	Infrastructure Improvements	2%						$2,555
	Project Management	5%						$6,388
	Remedial Design	8%						$10,221
	Construction Management	6%						$7,666
	Total Capital Cost							**$154,596**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0900	Risk Management - Annual Cost	5 - 30	1	LS	1,265	$1,265
1000	Five Year Review - First Review	5	1	EA	8,800	$8,800
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	5,500	$5,500
1100	Four to Five Year UXO Construction Support	5 - 30	0	EA	26,769	$0

PRESENT VALUE ANALYSIS:

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
Capital Cost	0	$154,596	$154,596	1	$154,596
Periodic Cost	5	$10,065	$10,065	0.854	$8,596
Periodic Cost	10	$6,765	$6,765	0.737	$4,986
Periodic Cost	15	$6,765	$6,765	0.633	$4,282
Periodic Cost	20	$6,765	$6,765	0.543	$3,673
Periodic Cost	25	$6,765	$6,765	0.467	$3,159
Periodic Cost	30	$6,765	$6,765	0.400	$2,706
		$198,486			$181,998
Total Present Value of Alternative					**$181,998**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Michie Stadium MRS
Alternative No: 3
MEC Surface Removal with Risk Management

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	0.80	LS	N/A	N/A	N/A	99,000	$79,200
0110	Explosives Safety Submission	1.00	LS	N/A	N/A	N/A	38,500	$38,500
0200	Mobilization	1.00	LS	N/A	N/A	N/A	57,865	$57,865
0300	Site Management	1.00	WK	1.0	1.0	1.48	20,985	$31,034
0310	Survey/Positioning	4.30	AC	5.0	2.0	0.09	15,522	$1,335
0320	Brush Clearing	0.43	AC	5.0	1.0	0.02	11,090	$191
0400	MEC Surface Removal	4.30	AC	1.0	1.0	0.86	42,304	$36,382
0410	MEC Removal to Detection Depth (M&D)	0.00	AC	0.0	0.0	0.00	42,689	$0
0420	Digital Geophysical Mapping	1.00	AC	0.0	0.0	0.00	20,932	$0
0430	Geophysical Data Analysis	1.00	AC	0.0	0.0	0.00	18,714	$0
0440	Anomaly Reacquisition	1.00	AC	0.0	0.0	0.00	4,965	$0
0450	MEC Subsurface Removal (DGM)	1.00	AC	0.0	0.0	0.00	42,689	$0
0500	MEC Disposal	5.00	EA	0.5	1.0	0.50	38,266	$19,133
0510	Scrap Disposal	5.00	EA	0.1	1.0	0.10	19,568	$1,957
0600	Site Restoration	0.04	AC	5.0	1.0	0.00	40,819	$70
0610	Demobilization	1.00	LS	N/A	N/A	N/A	12,925	$12,925
0700	Final Report	1.00	LS	N/A	N/A	N/A	77,000	$77,000
0800	Risk Management	1.00	LS	N/A	N/A	N/A	42,350	$42,350
	Sub-Total							$397,942
	Contingency	15%						$59,691
	Sub-Total							$457,633
	Infrastructure Improvements	2%						$9,153
	Project Management	5%						$22,882
	Remedial Design	8%						$36,611
	Construction Management	6%						$27,458
	Total Capital Cost							**$553,736**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0900	Risk Management - Annual Cost	5 - 30	1	LS	1,265	$1,265
1000	Five Year Review - First Review	5	1	EA	8,800	$8,800
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	5,500	$5,500
1100	Four to Five Year UXO Construction Support	5 - 30	0	EA	26,769	$0

PRESENT VALUE ANALYSIS:

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
Capital Cost	0	$553,736	$553,736	1	$553,736
Periodic Cost	5	$10,065	$10,065	0.854	$8,596
Periodic Cost	10	$6,765	$6,765	0.737	$4,986
Periodic Cost	15	$6,765	$6,765	0.633	$4,282
Periodic Cost	20	$6,765	$6,765	0.543	$3,673
Periodic Cost	25	$6,765	$6,765	0.467	$3,159
Periodic Cost	30	$6,765	$6,765	0.400	$2,706
		$597,626			$581,139
Total Present Value of Alternative					**$581,139**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Michie Stadium MRS
Alternative No: 4
MEC Removal Action to Detection Depth with Risk Management

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	99,000	$99,000
0110	Explosives Safety Submission	1.00	LS	N/A	N/A	N/A	38,500	$38,500
0200	Mobilization	1.00	LS	N/A	N/A	N/A	57,865	$57,865
0300	Site Management	1.00	WK	1.0	1.0	1.43	20,985	$30,050
0310	Survey/Positioning	4.30	AC	5.0	2.0	0.09	15,522	$1,335
0320	Brush Clearing	0.43	AC	3.0	1.0	0.03	11,090	$318
0400	MEC Surface Removal	0.00	AC	1.0	1.0	0.00	42,304	$0
0410	MEC Removal to Detection Depth (M&D)	3.30	AC	1.0	1.0	0.66	42,689	$28,175
0420	Digital Geophysical Mapping	1.00	AC	1.0	1.0	0.20	20,932	$4,186
0430	Geophysical Data Analysis	1.00	AC	1.0	1.0	0.20	18,714	$3,743
0440	Anomaly Reacquisition	1.00	AC	100.0	1.0	0.20	4,965	$993
0450	MEC Subsurface Removal (DGM)	1.00	AC	50.0	1.0	0.40	42,689	$17,076
0500	MEC Disposal	5.00	EA	0.5	1.0	0.50	38,266	$19,133
0510	Scrap Disposal	5.00	EA	0.1	1.0	0.10	19,568	$1,957
0600	Site Restoration	2.15	AC	3.0	1.0	0.14	40,819	$5,851
0610	Demobilization	1.00	LS	N/A	N/A	N/A	12,925	$12,925
0700	Final Report	1.00	LS	N/A	N/A	N/A	77,000	$77,000
0800	Risk Management	1.00	LS	N/A	N/A	N/A	42,350	$42,350
	Sub-Total							$440,456
	Contingency	15%						$66,068
	Sub-Total							$506,525
	Infrastructure Improvements	2%						$10,130
	Project Management	5%						$25,326
	Remedial Design	8%						$40,522
	Construction Management	6%						$30,391
	Total Capital Cost							**$612,895**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0900	Risk Management - Annual Cost	5 - 30	1	LS	1,265	$1,265
1000	Five Year Review - First Review	5	1	EA	8,800	$8,800
1010	Five Year Review - Years 10,15,20,25 & 30	10 - 30	1	EA	5,500	$5,500
1100	Four to Five Year UXO Construction Support	5 - 30	1	EA	26,769	$26,769

PRESENT VALUE ANALYSIS:

Cost Type	Year	Total Cost	Total Cost Per Year	Discount Factor (%)	Present Value
Capital Cost	0	$612,895	$612,895	1	$612,895
Periodic Cost	5	$36,834	$36,834	0.854	$31,456
Periodic Cost	10	$33,534	$33,534	0.737	$24,714
Periodic Cost	15	$33,534	$33,534	0.633	$21,227
Periodic Cost	20	$33,534	$33,534	0.543	$18,209
Periodic Cost	25	$33,534	$33,534	0.467	$15,660
Periodic Cost	30	$33,534	$33,534	0.400	$13,413
		$817,397			$737,574
Total Present Value of Alternative					**$737,574**

AC = acres, EA = each, LS = lump sum, N/A = not applicable, WK = week

Note: Only 4.3 acres of the MRS are accessible for a removal action. Because of terrain issues, only 1 acre is accessible for DGM; therefore, mag and dig will be used in the remaining 3.3 acres.

Feasibility Study Cost Estimate
Michie Stadium MRS
U.S. Army Garrison West Point

Michie Stadium MRS FS Cost Estimate					HO	Field							Total		Total
					Straight	Straight						SUBTOTAL		Subtotal +	
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	LABOR $	LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	COST	Raw	10%	Effort
0100	**Work Plans (incl. draft, draft-final, & final)**												**$90,000.00**		**$99,000.00**
	WP/APP/SSHP & GSV	1	LS	90,000.00					$90,000.00			$90,000.00		$99,000.00	
0110	**Explosives Safety Submission (incl. draft, draft-final, & final)**												**$35,000.00**		**$38,500.00**
	Explosives Safety Submission	1	LS	35,000.00					$35,000.00			$35,000.00		$38,500.00	
0200	**Mobilization (1 UXO Team [10hrs mob, 10hrs demob, mob per diem], Site Management Staff [40hrs mob, site prep, demob, mob per diem])**												**$33,323.35**		**$57,865.25**
	UXO Tech II (6 ea) (ST)	60	HR	37.21		$2,232.70						$2,232.70		$4,465.39	
	UXO Tech II (6 ea) (OT)	60	HR	55.82		$3,349.04						$3,349.04		$6,698.09	
	UXO Tech III (ST)	10	HR	43.86		$438.64						$438.64		$877.29	
	UXO Tech III (OT)	10	HR	65.80		$657.97						$657.97		$1,315.93	
	UXOSO/QCS (ST)	80	HR	44.65		$3,572.35								$7,144.70	
	UXOSO/QCS (OT)	20	HR	66.98		$1,339.63								$2,679.26	
	SUXOS (ST)	40	HR	48.86		$1,954.58								$3,909.15	
	SUXOS (OT)	10	HR	73.30		$732.97								$1,465.93	
	Sub: Mob Misc Equipment	5	EA	500.00					$2,500.00			$2,500.00		$2,750.00	
	Misc ODCs	10	DY	100.00							$1,000.00	$1,000.00		$1,100.00	
	Equip & Supplies	2	LS	1,000.00							$2,000.00	$2,000.00		$2,200.00	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Per Diem	63	DY	175.00			$11,025.00					$11,025.00		$12,127.50	
	Mob Allowance per Person	9	EA	1,000.00							$9,000.00	$9,000.00		$9,900.00	
0300	**Site Management (5-10hr days, per diem @ 7 dys/wk)**												**$13,167.53**		**$20,984.57**
	UXOSO (ST)	40	HR	44.65		$1,786.18						$1,786.18		$3,572.35	
	UXOSO (OT)	10	HR	66.98		$669.82						$669.82		$1,339.63	
	UXOQCS (ST)	40	HR	37.80		$1,512.00						$1,512.00		$3,024.00	
	UXOQCS (OT)	10	HR	56.70		$567.00						$567.00		$1,134.00	
	SUXOS (ST)	40	HR	48.86		$1,954.58						$1,954.58		$3,909.15	
	SUXOS (OT)	10	HR	73.30		$732.97						$732.97		$1,465.93	
	Computer	5	DY	10.00				$50.00				$50.00		$55.00	
	Copier/Fax	5	DY	5.00				$25.00				$25.00		$27.50	
	Printer	5	DY	10.00				$50.00				$50.00		$55.00	
	Internet Service	5	DY	5.00					$25.00			$25.00		$27.50	
	Generator w/FOG	5	DY	40.00				$200.00				$200.00		$220.00	
	Port-a-John	5	DY	10.00				$50.00				$50.00		$55.00	
	Storm Detector	5	DY	80.00				$400.00				$400.00		$440.00	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	SUV 4x4 w/FOG	7	DY	90.00				$630.00				$630.00		$693.00	
	Storage Box (CONEX)	7	DY	15.00				$105.00				$105.00		$115.50	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Cell Phone	5	DY	5.00							$25.00	$25.00		$27.50	
	Project Phone Service	5	DY	10.00							$50.00	$50.00		$55.00	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$275.00	
	Radios	7	DY	20.00							$140.00	$140.00		$154.00	
	Mechanics Tool Kit	5	DY	5.00							$25.00	$25.00		$27.50	
	Demolition Tool Kit	5	LS	20.00							$100.00	$100.00		$110.00	
	Per Diem	14	DY	175.00			$2,450.00					$2,450.00		$2,695.00	

Feasibility Study Cost Estimate
Michie Stadium MRS
U.S. Army Garrison West Point

Michie Stadium MRS FS Cost Estimate					HO Straight	Field Straight						SUBTOTAL	Total	Subtotal +	Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	LABOR $	LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	COST	Raw	10%	Effort
0310	**Survey/Positioning (UXO Tech II escort required for survey crew, 5-10hr dys, per diem @ 7 dys/wk)**												**$12,436.64**		**$15,522.28**
	UXO Tech II (ST)	40	HR	37.21		$1,488.46						$1,488.46		$2,976.93	
	UXO Tech II (OT)	10	HR	55.82		$558.17						$558.17		$1,116.35	
	Survey Sub	5	DY	1,500.00					$7,500.00			$7,500.00		$8,250.00	
	SUV 4x4 w/FOG	5	DY	90.00				$450.00				$450.00		$495.00	
	Surveyors Kit	5	DY	100.00				$500.00				$500.00		$550.00	
	Misc Small Tools/Equip	5	DY	50.00				$250.00				$250.00		$275.00	
	Computer	5	DY	10.00				$50.00				$50.00		$55.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Schonstedt	5	DY	10.00							$50.00	$50.00		$55.00	
	FOG	5	GL	3.00							$15.00	$15.00		$16.50	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	Per Diem	7	DY	175.00			$1,225.00					$1,225.00		$1,347.50	
0320	**Brush Clearing (5-10hr dys, per diem @ 7 dys/wk)**												**$7,428.04**		**$11,089.58**
	UXO Tech II (ST)	40	HR	37.21		$1,488.46						$1,488.46		$2,976.93	
	UXO Tech III (ST)	40	HR	43.86		$1,754.58						$1,754.58		$3,509.15	
	Brush Cutter, Power	5	DY	15.00				$75.00				$75.00		$82.50	
	Chain Saw	5	DY	15.00				$75.00				$75.00		$82.50	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$220.00	
	FOG	50	GL	3.00							$150.00	$150.00		$165.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Misc Small Tools/Equip	5	DY	50.00				$250.00				$250.00		$275.00	
	Mechanics Tool Kit	5	DY	5.00							$25.00	$25.00		$27.50	
	Pickup Truck 4x4 w/FOG	7	DY	80.00				$560.00				$560.00		$616.00	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	Schonstedt	5	DY	10.00							$50.00	$50.00		$55.00	
	Per Diem	14	DY	175.00			$2,450.00					$2,450.00		$2,695.00	
0400	**MEC Surface Removal (5-10hr dys, per diem @ 7 dys/wk)**												**$26,437.37**		**$42,304.24**
	UXO Tech II (6 ea) (ST)	240	HR	37.21		$8,930.78						$8,930.78		$17,861.57	
	UXO Tech II (6 ea) (OT)	60	HR	55.82		$3,349.04						$3,349.04		$6,698.09	
	UXO Tech III (ST)	40	HR	43.86		$1,754.58						$1,754.58		$3,509.15	
	UXO Tech III (OT)	10	HR	65.80		$657.97						$657.97		$1,315.93	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$220.00	
	FOG	50	GL	3.00							$150.00	$150.00		$165.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Schonstedt (6 ea)	30	DY	10.00							$300.00	$300.00		$330.00	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$275.00	
	Hand Held PDA (2)	10	DY	50.00							$500.00	$500.00		$550.00	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	Computer	5	DY	10.00				$50.00				$50.00		$55.00	
	Misc. H&S Equip	5	DY	50.00				$250.00				$250.00		$275.00	
	Per Diem	49	DY	175.00			$8,575.00					$8,575.00		$9,432.50	

Feasibility Study Cost Estimate
Michie Stadium MRS
U.S. Army Garrison West Point

Michie Stadium MRS FS Cost Estimate					HO Straight	Field Straight						Total		Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	LABOR $	LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	Subtotal + 10%	Effort
0410	**MEC Removal to Detection Depth (M&D) (5-10hr dys, per diem @ 7 dys/wk)**												**$26,787.37**		**$42,689.24**
	UXO Tech II (6 ea) (ST)	240	HR	37.21		$8,930.78						$8,930.78		$17,861.57	
	UXO Tech II (6 ea) (OT)	60	HR	55.82		$3,349.04						$3,349.04		$6,698.09	
	UXO Tech III (ST)	40	HR	43.86		$1,754.58						$1,754.58		$3,509.15	
	UXO Tech III (OT)	10	HR	65.80		$657.97						$657.97		$1,315.93	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$220.00	
	FOG	100	GL	3.00							$300.00	$300.00		$330.00	
	Schonstedt (6 ea)	30	DY	10.00							$300.00	$300.00		$330.00	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$275.00	
	Hand Held PDA	10	DY	50.00							$500.00	$500.00		$550.00	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Misc. H&S Equip	5	DY	50.00				$250.00				$250.00		$275.00	
	Excavation Tool Kit	5	DY	50.00							$250.00	$250.00		$275.00	
	Per Diem	49	DY	175.00			$8,575.00					$8,575.00		$9,432.50	
0420	**Digital Geophysical Mapping (DGM) (5-10hr dys, per diem @ 7 dys/wk)**												**$14,390.04**		**$20,932.08**
	Geophysical Technician (ST)	40	HR	30.24		$1,209.60						$1,209.60		$2,419.20	
	Geophysical Technician (OT)	10	HR	45.36		$453.60						$453.60		$907.20	
	Site Geophysicist (ST)	40	HR	35.64		$1,425.60						$1,425.60		$2,851.20	
	Site Geophysicist (OT)	10	HR	53.46		$534.60						$534.60		$1,069.20	
	UXO Tech II (ST)	40	HR	37.21		$1,488.46						$1,488.46		$2,976.93	
	UXO Tech II (OT)	10	HR	55.82		$558.17						$558.17		$1,116.35	
	Computer	5	DY	10.00				$50.00				$50.00		$55.00	
	Internet Service	5	DY	5.00					$25.00			$25.00		$27.50	
	Magnetometer	5	DY	125.00				$625.00				$625.00		$687.50	
	TDEM Detector	5	DY	125.00				$625.00				$625.00		$687.50	
	Positioning	5	DY	225.00				$1,125.00				$1,125.00		$1,237.50	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	GPS - RTK	5	DY	225.00							$1,125.00	$1,125.00		$1,237.50	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Per Diem	21	DY	175.00			$3,675.00					$3,675.00		$4,042.50	
0430	**Geophysical Data Analysis (5-10hr dys, per diem @ 7 dys/wk)**												**$11,415.50**		**$18,713.51**
	Project Geophysicist (ST)	40	HR	56.33		$2,253.31						$2,253.31		$4,506.62	
	Project Geophysicist (OT)	10	HR	84.50		$844.99						$844.99		$1,689.98	
	Site Geophysicist (ST)	40	HR	35.64		$1,425.60						$1,425.60		$2,851.20	
	Site Geophysicist (OT)	10	HR	53.46		$534.60						$534.60		$1,069.20	
	CADD/GIS Operator (ST)	40	HR	32.40		$1,296.00						$1,296.00		$2,592.00	
	CADD/GIS Operator (OT)	10	HR	48.60		$486.00						$486.00		$972.00	
	Cell Phone	5	DY	5.00							$25.00	$25.00		$27.50	
	Computer	5	DY	10.00				$50.00				$50.00		$55.00	
	Internet Service	5	DY	5.00					$25.00			$25.00		$27.50	
	Printer	5	DY	10.00				$50.00				$50.00		$55.00	
	SUV 4x4 w/FOG	5	DY	90.00				$450.00				$450.00		$495.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Project Phone Service	5	DY	10.00							$50.00	$50.00		$55.00	
	Per Diem	21	DY	175.00			$3,675.00					$3,675.00		$4,042.50	

Feasibility Study Cost Estimate
Michie Stadium MRS
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Michie Stadium MRS FS Cost Estimate					HO	Field							Total		Total
					Straight	Straight								Subtotal +	
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	LABOR $	LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	10%	Effort
0440	**Anomaly Re-Acquisition (5-10hr dys, per diem @ 7 dys/wk)**												**$4,361.06**		**$4,964.62**
	UXO Tech II	5	HR	37.21		$186.06						$186.06		$372.12	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	GPS - RTK	5	DY	225.00							$1,125.00	$1,125.00		$1,237.50	
	USRAD	5	DY	225.00				$1,125.00				$1,125.00		$1,237.50	
	SUV 4x4 w/FOG	5	DY	90.00				$450.00				$450.00		$495.00	
	Per Diem	7	DY	175.00			$1,225.00					$1,225.00		$1,347.50	
0450	**MEC Subsurface Removal (DGM) (5-10hr dys, per diem @ 7 dys/wk)**												**$26,787.37**		**$42,689.24**
	UXO Tech II (6) (ST)	240	HR	37.21		$8,930.78						$8,930.78		$17,861.57	
	UXO Tech II (6) (OT)	60	HR	55.82		$3,349.04						$3,349.04		$6,698.09	
	UXO Tech III (ST)	40	HR	43.86		$1,754.58						$1,754.58		$3,509.15	
	UXO Tech III (OT)	10	HR	65.80		$657.97						$657.97		$1,315.93	
	Heavy Equip Operator (ST)	0	HR	29.28		$0.00						$0.00		$0.00	
	Heavy Equip Operator (OT)	0	HR	43.91		$0.00						$0.00		$0.00	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Universal Loader/Backhoe w/FOG	0	DY	60.00				$0.00				$0.00		$0.00	
	Trailer Flat Bed	0	DY	15.00				$0.00				$0.00		$0.00	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$220.00	
	FOG	100	GL	3.00							$300.00	$300.00		$330.00	
	Schonstedt (6 ea)	30	DY	10.00							$300.00	$300.00		$330.00	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$275.00	
	Hand Held PDA	10	DY	50.00							$500.00	$500.00		$550.00	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$275.00	
	Misc. H&S Equip	5	DY	50.00				$250.00				$250.00		$275.00	
	Excavation Tool Kit	5	DY	50.00							$250.00	$250.00		$275.00	
	Per Diem	49	DY	175.00			$8,575.00					$8,575.00		$9,432.50	
0500	**MEC Disposal (5-10hr dys, per diem @ 7 dys/wk)**												**$24,440.73**		**$38,265.96**
	UXO Tech II (6 ea) (ST)	200	HR	37.21		$7,442.32						$7,442.32		$14,884.64	
	UXO Tech II (6 ea) (OT)	50	HR	55.82		$2,790.87						$2,790.87		$5,581.74	
	UXO Tech III (ST)	40	HR	43.86		$1,754.58						$1,754.58		$3,509.15	
	UXO Tech III (OT)	10	HR	65.80		$657.97						$657.97		$1,315.93	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$220.00	
	Hand Held PDA	10	DY	50.00							$500.00	$500.00		$550.00	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	Misc ODCs (picks & shovels)	5	DY	30.00				$150.00				$150.00		$165.00	
	Misc. H&S Equip	5	DY	50.00				$250.00				$250.00		$275.00	
	Donor Explosives	5	DY	100.00							$500.00	$500.00		$550.00	
	Explosives Vehicle	5	DY	80.00				$400.00				$400.00		$440.00	
	Per Diem	49	DY	175.00			$8,575.00					$8,575.00		$9,432.50	
0510	**Scrap Disposal (5-10hr dys, per diem @ 7 dys/wk)**												**$12,465.82**		**$19,567.64**
	UXO Tech II (2 ea) (ST)	80	HR	37.21		$2,976.93						$2,976.93		$5,953.86	
	UXO Tech II (2 ea) (OT)	20	HR	55.82		$1,116.35						$1,116.35		$2,232.70	
	UXO Tech III (ST)	40	HR	43.86		$1,754.58						$1,754.58		$3,509.15	
	UXO Tech III (OT)	10	HR	65.80		$657.97						$657.97		$1,315.93	
	Pickup Truck 4x4 w/FOG	7	DY	80.00				$560.00				$560.00		$616.00	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$220.00	
	FOG	50	GL	3.00							$150.00	$150.00		$165.00	
	Radios	5	DY	20.00							$100.00	$100.00		$110.00	
	Misc ODCs (picks & shovels)	5	DY	30.00				$150.00				$150.00		$165.00	
	Recycler - Scrap Disposal	5	DY	225.00				$1,125.00				$1,125.00		$1,237.50	
	Per Diem	21	DY	175.00			$3,675.00					$3,675.00		$4,042.50	

Feasibility Study Cost Estimate
Michie Stadium MRS
U.S. Army Garrison West Point

Michie Stadium MRS FS Cost Estimate					HO	Field							Total		Total
					Straight	Straight						SUBTOTAL		Subtotal +	
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	LABOR $	LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	COST	Raw	10%	Effort
0600	**Site Restoration (2 Laborers required to fill and compact holes left from anomaly investigation)**												**$25,087.37**		**$40,819.24**
	UXO Tech II (6 ea) (ST)	240	HR	37.21		$8,930.78						$8,930.78		$17,861.57	
	UXO Tech II (6 ea) (OT)	60	HR	55.82		$3,349.04						$3,349.04		$6,698.09	
	UXO Tech III (ST)	40	HR	43.86		$1,754.58						$1,754.58		$3,509.15	
	UXO Tech III (OT)	10	HR	65.80		$657.97						$657.97		$1,315.93	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Misc Small Tools/Equip	5	DY	40.00				$200.00				$200.00		$220.00	
	Fill Materials	50	CY	10.00							$500.00	$500.00		$550.00	
	Per Diem	49	DY	175.00			$8,575.00					$8,575.00		$9,432.50	
0610	**Demobilization (Demob expenses)**												**$11,750.00**		**$12,925.00**
	Sub: Demob Misc Equipment	5	EA	500.00					$2,500.00			$2,500.00		$2,750.00	
	Misc ODCs	5	DY	50.00							$250.00	$250.00		$275.00	
	Demob Allowance per Person	9	EA	1,000.00							$9,000.00	$9,000.00		$9,900.00	
0700	**Final Report (incl. draft, draft-final, & final)**												**$70,000.00**		**$77,000.00**
	Final Report	1	LS	70,000.00					$70,000.00			$70,000.00		$77,000.00	
0800	**Risk Management**												**$38,500.00**		**$42,350.00**
	Containment and Controls Plan	1	EA	5,000.00					$5,000.00			$5,000.00		$5,500.00	
	Signs	20	EA	150.00					$3,000.00			$3,000.00		$3,300.00	
	Brochure/Fact Sheet	2	LS	1,000.00					$2,000.00			$2,000.00		$2,200.00	
	Prepare & Distribute Videos/DVDs	1	LS	20,000.00					$20,000.00			$20,000.00		$22,000.00	
	Update Websites	2	LS	2,000.00					$4,000.00			$4,000.00		$4,400.00	
	TRC (per mtg)	3	LS	1,500.00					$4,500.00			$4,500.00		$4,950.00	
0900	**Risk Management - Annual Cost**												**$1,150.00**		**$1,265.00**
	Signs	1	EA	150.00					$150.00			$150.00		$165.00	
	Brochure/Fact Sheet	0.5	LS	1,000.00					$500.00			$500.00		$550.00	
	Prepare & Distribute Videos/DVDs	0.5	LS	500.00					$250.00			$250.00		$275.00	
	TRC (per mtg)	0.5	LS	500.00					$250.00			$250.00		$275.00	
1000	**5Y Review - 1st Review**												**$8,000.00**		**$8,800.00**
	Recurring Review Plan	1	EA	3,000.00					$3,000.00			$3,000.00		$3,300.00	
	Document Reviews	1	EA	1,000.00					$1,000.00			$1,000.00		$1,100.00	
	Site Inspection	1	EA	2,000.00					$2,000.00			$2,000.00		$2,200.00	
	Report	1	EA	2,000.00					$2,000.00			$2,000.00		$2,200.00	
1010	**5Y Rev - Remaining Reviews**												**$5,000.00**		**$5,500.00**
	Document Reviews	1	EA	1,000.00					$1,000.00			$1,000.00		$1,100.00	
	Site Inspection	1	EA	2,000.00					$2,000.00			$2,000.00		$2,200.00	
	Report	1	EA	2,000.00					$2,000.00			$2,000.00		$2,200.00	
1100	**UXO Construction Support**												**$17,038.36**		**$26,768.72**
	UXO Tech II (ST)	80	HR	37.21		$2,976.93						$2,976.93		$5,953.86	
	UXO Tech II (OT)	20	HR	55.82		$1,116.35						$1,116.35		$2,232.70	
	UXO Tech III (ST)	80	HR	43.86		$3,509.15						$3,509.15		$7,018.30	
	UXO Tech III (OT)	20	HR	65.80		$1,315.93						$1,315.93		$2,631.86	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	80.00				$1,120.00				$1,120.00		$1,232.00	
	Hand Held PDA	14	DY	50.00							$700.00	$700.00		$770.00	
	Radios	14	DY	20.00							$280.00	$280.00		$308.00	
	Misc ODCs (picks & shovels)	14	DY	30.00				$420.00				$420.00		$462.00	
	Misc. H&S Equip	14	DY	50.00				$700.00				$700.00		$770.00	
	Donor Explosives	0	DY	100.00							$0.00	$0.00		$0.00	
	Explosives Vehicle	0	DY	80.00				$0.00				$0.00		$0.00	
	Per Diem	28	DY	175.00			$4,900.00					$4,900.00		$5,390.00	

APPENDIX B

MEC HAZARD ASSESSMENTS FOR ALTERNATIVES

MEC Hazard Assessment Scoring Summary

Site ID:	Michie Stadium	a. Scoring Summary for Current Use Activities	
Date:	7/5/2012	Response Action Cleanup:	No Response Action
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptor		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		10,000 to 99,999 receptor-hrs/yr	40
V. Amount of MEC		Safety Buffer Areas	30
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.	150
VII. Migration Potential		Unlikely	10
VIII. MEC Classification		Unfuzed DMM	45
IX. MEC Size		Small	40
		Total Score	**525**
		Hazard Level Category	**4**

MEC HA Hazard Level Determination			
Site ID:	Michie Stadium		
Date:	7/5/2012	Hazard Level Category	Score
a. Current Use Activities		4	525
c. Response Alternative 1: No Action		4	525
d. Response Alternative 2: Risk Management		4	425
e. Response Alternative 3: Surface Removal with Risk Management		4	335
f. Response Alternative 4: Subsurface Removal to Instrument Detection Depth with Risk Management		4	345

Characteristics of the MRS	
Is critical infrastructure located within the MRS or within the ESQD arc?	Yes
Are cultural resources located within the MRS or within the ESQD arc?	Yes
Are significant ecological resources located within the MRS or within the ESQD arc?	No

MEC HA Summary Information

		Comments
Site ID:	Michie Stadium	
Date:	7/5/2012	

Please identify the single specific area to be assessed in this hazard assessment. From this point forward, all references to "site" or "MRS" refer to the specific area that you have defined.

A. Enter a unique identifier for the site:

(WSTPT-022-R-01) Michie Stadium

Provide a list of information sources used for this hazard assessment. As you are completing the worksheets, use the "Select Ref(s)" buttons at the ends of each subsection to select the applicable information sources from the list below.

Ref. No.	Title (include version, publication date)
1	Site Inspection, Final, 2007
2	Field Investigations, 2011
3	http://www.goarmysports.com/facilities/michie-stadium.html
4	Remedial Investigation Explosives Site Plan Amendment 1, 2011
5	Remedial Investigation, Final, 2012
6	
7	
8	
9	
10	
11	
12	

B. Briefly describe the site:

1. Area (include units):	Approximately 14.1 acres	
2. Past munitions-related use:		
Safety Buffer Areas		
3. Current land-use activities (list all that occur):		
Recreational and athletic activities		
4. Are changes to the future land-use planned?	No	Future construction will not change current land use.
5. What is the basis for the site boundaries?		
Current stadium boundaries, to include parking lots and buildings.		
6. How certain are the site boundaries?		
Confident in boundaries.		

Reference(s) for Part B:

C. Historical Clearances

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

Reference(s) for Part C:

1 & 2

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

Site ID: **Michie Stadium**
Date: **7/5/2012**

Cased Munitions Information

Item No.	Munition Type (e.g., mortar, projectile, etc.)	Munition Size	Munition Size Units	Mark/ Model	Energetic Material Type	Is Munition Fuzed?	Fuzing Type	Fuze Condition	Minimum Depth for Munition (ft)	Location of Munitions	Comments (include rationale for munitions that are "subsurface only")
1	Mortars	3	inches	MKI (Stokes)	High Explosive	No	Impact	Unarmed	0.5	Subsurface Only	Unfuzed mortar removed from site.
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											
16											
17											
18											
19											
20											

Reference(s) for table above:

Item No.	Explosive Type	Comments
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

Reference(s) for table above:

Site ID: **Michie Stadium**
Date: **7/5/2012**

Activities Currently Occurring at the Site

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Athletics and visitors	10,000	8	80,000	0	Exposure time to non hard surface areas for 16 events at 1/2 hour per event.
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			**80,000**		
	Maximum intrusive depth at site (ft):				**0**	

Reference(s) for table above:

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

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Construction of an additional athletic building within the ESQD arc for athletics.	40,000	16	**80,000**	0	Future construction within the MRS will not change the current land use. Exposure time to non hard surface areas for 32 events at 1/2 hour per event.
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
	Total Potential Contact Time (receptor hrs/yr):			**80,000**		
	Maximum intrusive depth at site (ft):				**0**	

Reference(s) for table above:

Site ID: **Michie Stadium**
Date: **7/5/2012**

Planned Remedial or Removal Actions

Response Action No.	Response Action Description	Expected Resulting Minimum MEC Depth (ft)	Expected Resulting Site Accessibility	Will land use activities change if this response action is implemented?	What is the expected scope of cleanup?	Comments
1	No Action	0.5	Full Accessibility	No	No MEC cleanup	
2	Risk Management	0.5	Full Accessibility	No	No MEC cleanup	Includes LUCP, potential signage, awareness program, brochures, videos, and UXO Construction Support
3	Surface Removal with Risk Management	0.5	Full Accessibility	No	Cleanup of MECs located on the surface only	Done over 4.3 acres with Risk Management listed above.
4	Subsurface Removal to Instrument Detection Depth with Risk Management	3	Full Accessibility	No	Cleanup of MECs located both on the surface and subsurface	Done over 4.3 acres, with Risk Management listed above
5						
6						

According to the 'Summary Info' worksheet, no future land uses are planned. For those alternatives where you answered 'No' in Column E, the land use activities will be assessed against current land uses.

Reference(s) for table above:

Site ID: **Michie Stadium**
Date: **7/5/2012**

Energetic Material Type Input Factor Categories

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

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

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

Score

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

Location of Additional Human Receptors Input Factor Categories

1. What is the Explosive Safety Quantity Distance (ESQD) from the Explosive Siting Plan or the Explosive Safety Submission for the MRS? 225 feet

Intentional detonations, hazardous fragment distance.

2. Are there currently any features or facilities where people may congregate within the MRS, or within the ESQD arc? Yes

3. Please describe the facility or feature.

Sports stadium for football and lacrosse.

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

3" Stokes Mortar (MK1)

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

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

4. Current use activities are 'Inside the MRS or inside the ESQD arc', based on Question 2.'

Score

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

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

6. Future plans include the construction of an additional athletic building within the ESQD arc.

Current land use will not change.

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

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

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

7. Future use activities are 'Inside the MRS or inside the ESQD arc', based on Question 5.'

Score

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

Comments

Site Accessibility Input Factor Categories

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

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

Current Use Activities

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

`Full Accessibility`

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

Future Use Activities

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

	Score
Baseline Conditions:	
Surface Cleanup:	
Subsurface Cleanup:	

Reference(s) for above information:

Response Alternative No. 1: No Action

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

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

Response Alternative No. 2: Risk Management

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

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

Response Alternative No. 3: Surface Removal with Risk Management

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

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

Response Alternative No. 4: Subsurface Removal to Instrument Detection Depth with Risk Management

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

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

Response Alternative No. 5:

Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.

	Score
Baseline Conditions:	
Surface Cleanup:	
Subsurface Cleanup:	

Response Alternative No. 6:

Please enter site accessibility information in the 'Planned Remedial or Removal Actions' Worksheet to continue.

	Score
Baseline Conditions:	
Surface Cleanup:	
Subsurface Cleanup:	

Potential Contact Hours Input Factor Categories

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

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

Current Use Activities:

Input factors are only determined for baseline conditions for current use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is:

80,000 receptor hrs/yr

Based on the table above, this corresponds to a input factor score for baseline conditions of:

40 Score

Amount of MEC Input Factor Categories

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

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

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

`Safety Buffer Areas`

Baseline Conditions: **30**
Surface Cleanup: **10**
Subsurface Cleanup: **5**

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

Current Use Activities

The shallowest minimum MEC depth, based on the 'Cased Munitions Information' Worksheet: **0.5** ft
The deepest intrusive depth: **0.5** ft

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

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

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth will overlap after cleanup. MECs are located only subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.' For 'Current Use Activities', only Baseline Conditions are considered.

150 *Score*

Future Use Activities

Deepest intrusive depth: **10** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located only subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located only subsurface. Baseline Condition or After Cleanup: Intrusive depth overlaps with minimum MEC depth.'. For 'Future Use Activities', only Baseline Conditions are considered.

150 *Score*

Migration Potential Input Factor Categories

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

No

Frost heave would be an unreasonable migration factor based on improved ground.

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

Frost heave or movement from original placement from human processes (e.g., construction) unlikely

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

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

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

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

Reference(s) for above information:

MEC Classification Input Factor Categories

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

The 'Amount of MEC' category is 'Safety Buffer Areas'. It cannot be automatically assumed that the MEC items from this category are DMM. However, because all cased munitions are unarmed (see 'Munitions, Bulk Explosive Info' Worksheet), it is assumed that the MEC items are DMM.

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

Are any of the munitions listed in the 'Munitions, Bulk Explosive Info' Worksheet: No

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

None of the items listed in the 'Munitions, Bulk Explosive Info' Worksheet were identified as 'fuzed'.

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

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

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

	Score
Baseline Conditions:	**45**
Surface Cleanup:	**45**
Subsurface Cleanup:	**45**

MEC Size Input Factor Categories

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

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

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

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