FINAL
FEASIBILITY STUDY

NANTUCKET BEACH, FORMER NANTUCKET ORDNANCE SITE A.K.A. TOM NEVERS ROCKET PROJECTILE TARGET; TOM NEVERS AREA, FORMERLY USED DEFENSE SITE PROJECT NUMBER D01MA045601 AERIAL ROCKET RANGE TARGET #1 MUNITIONS RESPONSE SITE NANTUCKET, MASSACHUSETTS

MILITARY MUNITIONS RESPONSE PROGRAM

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LIST OF ACRONYMS

°F	degrees Fahrenheit
%	percent
µg/L	micrograms per liter
ARAR	Applicable or Relevant and Appropriate Requirements
ASR	Archives Search Report
BIP	blown-in-place
bgs	below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	Conceptual Site Model
DERP	Defense Environmental Restoration Program
DGM	digital geophysical mapping
DGPS	Differential Global Positioning System
DMM	discarded military munitions
DoD	Department of Defense
DQO	data quality objective
EMI	electromagnetic induction
EOD	Explosives Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ESTCP	Environmental Security Technology Certification Program
FDEMI	frequency-domain electromagnetic induction
FFAR	forward firing aircraft rocket
FS	Feasibility Study
ft	feet
FUDS	Formerly Used Defense Site
GPS	Global Positioning System
HE	high explosive
HFA	Human Factors Applications, Inc./TerranearPMC, LLC
HVAR	high velocity aircraft rocket

LIST OF ACRONYMS
(Concluded)

IC	institutional control
IR	infrared
LTM	long-term management
LUC	Land Use Control
MassDEP	Massachusetts Department of Environmental Protection
MassGIS	Massachusetts Geographic Information System
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
MEC HA	Munitions and Explosives of Concern Hazard Assessment
MGFD	munition with the greatest fragmentation distance
mg/kg	milligrams per kilogram
MMRP	Military Munitions Response Program
MPPEH	material potentially presenting an explosive hazard
MRS	munitions response site
MSD	minimum separation distance
Nantucket Beach FUDS	Nantucket Beach, Former Nantucket Ordnance Site, a.k.a. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site, Project Number D01MA045601, Nantucket, Massachusetts
NCF	Nantucket Conservation Foundation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NHESP	Natural Heritage and Endangered Species Program
NMFS	U.S. National Marine Fisheries Service
OCZM	Office of Coastal Zone Management
OE	ordnance and explosive
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	Remedial Investigation
ROE	Right-of-Entry
RSP	render safe procedures
RTS	robotic total station

LIST OF ACRONYMS (Concluded)

SAM	sub audio magnetics
SAR	synthetic aperture radar
SARA	Superfund Amendments and Reauthorization Act of 1986
SCAR	sub-caliber aircraft rocket
SI	Site Inspection
TBC	to be considered
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
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USRADS	Ultrasonic Ranging and Data System
UU/UE	unlimited use and unrestricted exposure
UXO	unexploded ordnance
VRHabilis	VRHabilis, LLC
WAA	Wide Area Assessment
WESTON®	Weston Solutions, Inc.
WPA	Wellhead Protection Area

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The United States (U.S.) Army Corps of Engineers is conducting a Feasibility Study (FS) at the Nantucket Beach, Former Nantucket Ordnance Site, a.k.a. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site (FUDS), Project Number D01MA045601, located on Nantucket Island, Massachusetts to address munitions debris (MD) present at the Munitions Response Site (MRS). The Remedial Investigation (RI) was conducted in 2012, and the results are presented under separate cover in the *Final Remedial Investigation Report for the Nantucket Beach, Former Nantucket Ordnance Site A.K.A. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site* [Weston Solutions, Inc. (WESTON®), 2013]. The data collected and the conclusions drawn in the RI Report were used to develop this FS Report specifically addressing the Aerial Rocket Range Target #1 MRS at the FUDS.

The Aerial Rocket Range Target #1 MRS is comprised of 97 acres of land of the 2,986 acres FUDS property located on the southeastern side of Nantucket Island in what is referred to as the Tom Nevers area in Nantucket, Nantucket County, Massachusetts (see **Figure 1-1**). During World War II training exercises, U.S. Navy pilots fired air-to-ground rockets at three potential ordnance sites (designated Target #1, Target #2, and Target #3) identified via historical records and imagery. Prior to the RI, the FUDS was conservatively realigned as one MRS which included 5,157 acres of land and coastal water which encompassed all three potentially used targets, associated range fans, and a 1.5-acre potential burial pit area. Following the RI, the MRS was delineated into two MRSs as follows:

- **Aerial Rocket Range Target #1 MRS**—This MRS (recommended for an FS following the RI) is approximately 97 acres and includes the delineated impact area around former Target #1 where MD was characterized during the RI and munitions have been responded to historically at the FUDS. No munitions and explosives of concern (MEC) were discovered during the RI. Based on the extent of MD characterized, this MRS includes the 1.5-acre area formerly suspected to have been used as a burial pit, however, no features indicative of a burial pit were identified during the RI.

- **Aerial Rocket Range Fan MRS**—This MRS [recommended for no action following the RI] includes the approximately 5,060 acres remaining land and coastal water area following impact area delineation. This MRS includes the locations of where the

suspected former Target #2 and Target #3 were located and the associated range fan area. There was no evidence of military munitions-related materials identified in this MRS during the RI.

This FS addresses the Aerial Rocket Range Target #1 MRS. No unexploded ordnance or discarded military munitions were identified during the investigation. However, MD was observed throughout the 97-acre MRS, and is estimated to be present at significant densities from 0.1 MD/acre to greater than 40 MD/acre. A total of 938 MD items were recovered at ground surface, and in subsurface soil down to 8 feet (ft) below ground surface (bgs) during the RI. Although there is a low statistical potential for MEC to be present, based on the findings of the RI, it is not expected that a MEC source or explosive safety hazard exists. The significant amount of MD within the MRS does indicate that property users will likely continue to encounter intact inert practice rockets in the future. Although munitions recovered in the future will most likely be inert, this determination should only be made by trained authorities.

The land within the 97-acre MRS boundary, where MD was removed, is currently owned by private residents or the Nantucket Conservation Foundation (NCF). On non-residential portions of the MRS, recreational use of the beach and along established paths in the undeveloped uplands portion of the MRS is allowed. There is no anticipated change in land use. The land within the MRS boundary consists of: maintained landscaping; upland scrub vegetation; beach grass dunes/bluffs; and includes the beach below the bluffs where munitions have been historically discovered due to extensive and on-going coastal erosion that periodically causes subsurface munitions to fall out onto the beach.

The purpose of this FS is to identify, develop, and perform a detailed analysis of potential remedial alternatives that would meet the remedial action objective (RAO). The RAO for the Aerial Rocket Range Target #1 MRS is:

> *Reduce the probability of residents, NCF personnel, contractor/maintenance workers, visitors/trespassers, and recreational users from handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil.*

Once the RAO was established, remedial alternatives were developed for the Aerial Rocket Range Target #1 MRS. The RAO assisted in focusing the comparison of acceptable remedial action alternatives and in clarifying an acceptable level of protection for human health and the environment. These objectives are required to meet the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) criteria.

Remedial alternatives, ranging from no action to clearance of remaining munitions, were then evaluated for each MRS based on current and anticipated future land use, protectiveness and effectiveness, and ability to achieve risk-reduction goals. These alternatives are:

- Alternative 1 – No Action (required to be evaluated in accordance with the NCP).
- Alternative 2 – Land Use Control(s) (LUC) and Long-Term Management (LTM).
- Alternative 3 – Surface clearance to address the beach and NCF trails for recreational use and portions of residential properties where ground surface is accessible (approximately 25.7 acres) with LUCs and LTM.
- Alternative 4 – Surface clearance per Alternative 3 with additional subsurface clearance to 4 ft bgs over 3 acres of residential properties in accessible areas to support future construction/maintenance activities with LUCs and LTM.
- Alternative 5 – Surface and subsurface clearance per Alternative 4 with additional subsurface clearance to 10 ft bgs with LUCs and LTM.
- Alternative 6 – Surface and subsurface clearance to 10 ft bgs within the boundary of the MRS (approximately 88.8 acres).

Remedial alternatives deemed highly viable for use at the Aerial Rocket Range Target #1 MRS were assessed in a detailed analysis against the evaluation criteria required by Section 300.430 of the NCP, and described in Subsection 5.1 of this document. Based on the detailed analysis of remedial alternatives, the strengths and weaknesses of the remedial alternatives relative to one another were evaluated with respect to each of the NCP criteria. The results of this comparative analysis for the Aerial Rocket Range Target #1 MRS are summarized in **Table ES-1**. This approach to analyzing alternatives is designed to provide decision-makers with sufficient information to adequately compare the alternatives, select an appropriate remedy for the MRS, and demonstrate satisfaction of the Comprehensive Environmental Response, Compensation, and Liability Act remedy selection requirements in the Decision Document.

Table ES-1

Comparative Analysis Summary

	Screening Criterion	Alternative 1: No Action	Alternative 2: Land Use Controls (LUCs) and Long-Term Management (LTM)	Alternative 3: Surface Clearance (25.7 acres) with LUCs and LTM	Alternative 4: Surface (25.7 acres) and Subsurface Clearance to 4ft bgs (3 acres) with LUCs and LTM	Alternative 5: Surface (25.7 acres) and Subsurface Clearance to 10 ft bgs (3 acres) with LUCs and LTM	Alternative 6: Surface and Subsurface Clearance to 10 ft bgs (88.8 acres)
Threshold	Overall Protection of Human Health and Environment	○	●	●	●	●	○
	Compliance with ARARs	●	●	●	●	●	○
Balancing	Long-Term Effectiveness	○	●	●	●	●	●
	Reduction of TMV through Treatment	○	◑	◑	◑	◑	●
	Short-Term Effectiveness	●	●	◑	◑	◑	○
	Implementability	●	●	●	◑	◑	○
	-Technical Feasibility	●	●	●	●	◑	◑
	-Administrative Feasibility	●	●	●	◑	◑	○
	-Availability of Materials and Services	●	●	●	●	◑	◑
	Cost[1]	$0	$206,000	$1,096,000	$2,517,000	$2,731,000	$22,394,000
Modifying[2]	State Acceptance	TBD	TBD	TBD	TBD	TBD	TBD
	Community Acceptance	TBD	TBD	TBD	TBD	TBD	TBD

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

[1] Costs are detailed in Appendix C and have been rounded to the nearest thousand.
[2] The modifying criteria will be evaluated following review and input from these parties.
ARAR = Applicable or Relevant and Appropriate Requirement
LTM = Long-Term Management
LUC = Land Use Controls
TBD = to be determined
TMV = toxicity, mobility or volume

SECTION 1

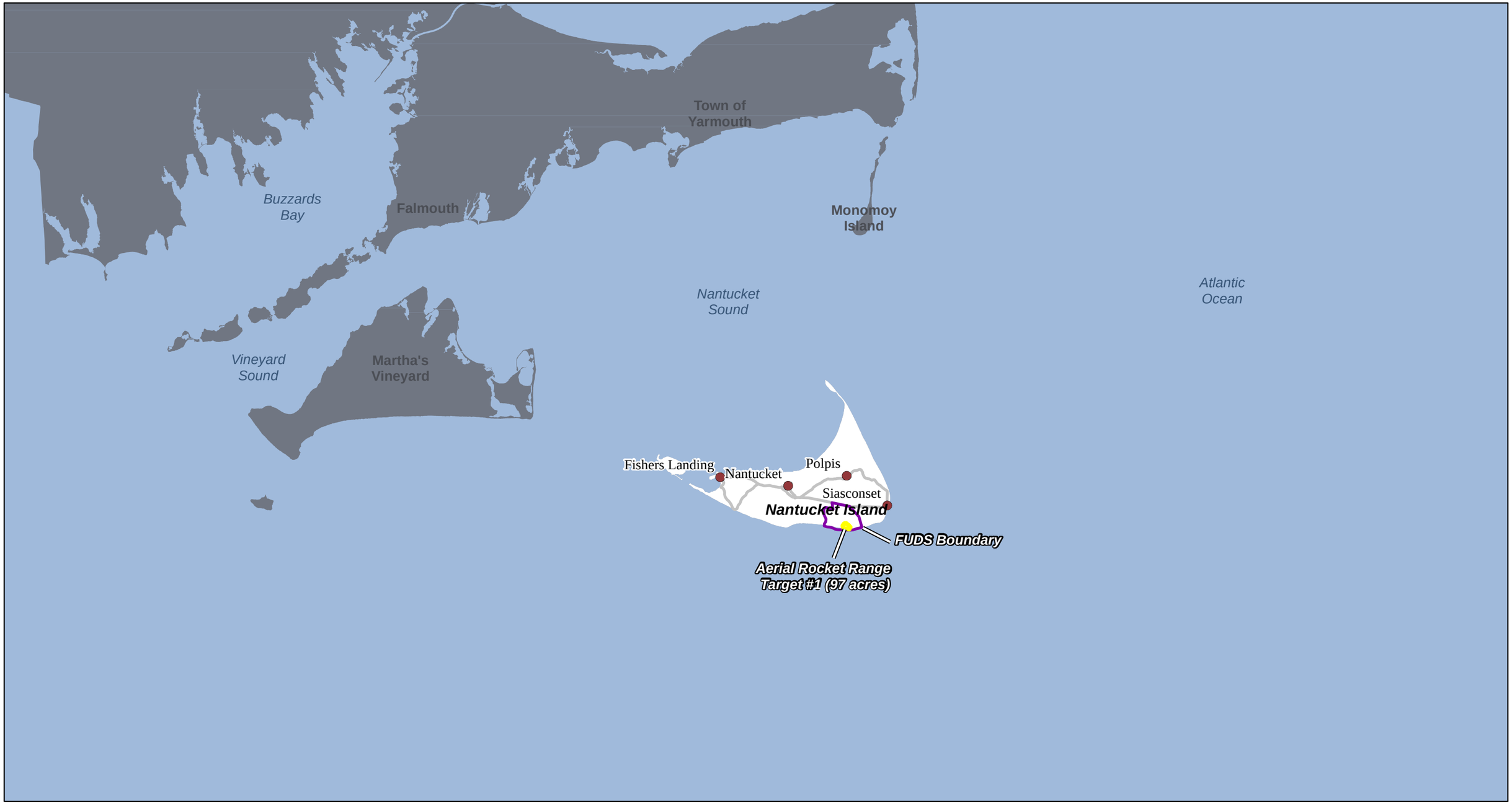
INTRODUCTION

1. INTRODUCTION

This report documents the results of a Feasibility Study (FS) conducted within the Nantucket Beach, Former Nantucket Ordnance Site, a.k.a. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site (FUDS), Project Number D01MA045601, located on Nantucket Island, Massachusetts (see **Figure 1-1**). This FUDS will be referred to henceforth as the Nantucket Beach FUDS. This FS was performed in support of the Department of Defense (DoD) Military Munitions Response Program (MMRP). Weston Solutions, Inc., (WESTON®) was authorized to conduct the FS through a firm fixed price, Performance-Based Acquisition under the United States (U.S.) Army Corps of Engineers (USACE), Baltimore District Multiple Award Military Munitions Services Contract W912DR-09-D-006, Delivery Order 0005. The FS was conducted in accordance with the *Performance Work Statement* (USACE, 2011a) issued for Delivery Order 0005; the procedures established for managing and executing military munitions response actions in Engineer Pamphlet No. 1110-1-18 (USACE, 2006); and, with respect to Engineer Regulation 200-3-1 (USACE, 2004), which provides the specific policy and guidance for management and execution of the FUDS program.

The remedial alternatives designed and evaluated in detail and comparatively in this FS address a 97-acre portion of the FUDS delineated as the Aerial Rocket Range Target #1 Munitions Response Site (MRS) following a Remedial Investigation (RI) performed in 2012. The MRS boundary is depicted on **Figure 1-2**. The results of the RI are documented in the *Final Remedial Investigation Report, Nantucket Beach, Former Nantucket Ordnance Site A.K.A. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site, Nantucket, MA* (WESTON, 2013).

Prior to the RI, this FUDS was realigned at the program-level by USACE as the 5,157-acre Nantucket Beach Burial Pit & Rocket Range (under Identification Number: 01MA045601R01).



Aerial Rocket Range Target #1

FUDS Boundary

Coordinate System: UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 4.5 9 18 Kilometers

0 2.5 5 10 15 Miles

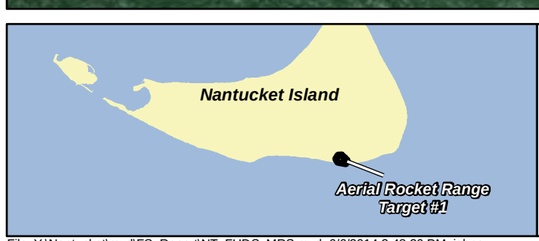
NOTES:
Base Data: USACE (2004)

FIGURE 1-1
FUDS and MRS Regional Location
Nantucket, MA

2/3/2014 | NT_Site_Location

Drawn: johna | PROJ: 03886.551.004

File: Y:\Nantucket\mxd\FS_Report\NT_Site_Location.mxd, 2/3/2014 11:22:28 AM, johna



T-1 Former Target

Aerial Rocket Range Target #1 MRS Boundary

FUDS Boundary

Coordinate System:
UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 380 760 1,140 Feet

0 140 280 420 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004)

FIGURE 1-2
Aerial Rocket Range Target 1 MRS [D01MA045601] Boundary
Nantucket, MA

6/6/2014	NT_FUDS_MRS_2V
Drawn: johna	PROJ: 03886.551.004

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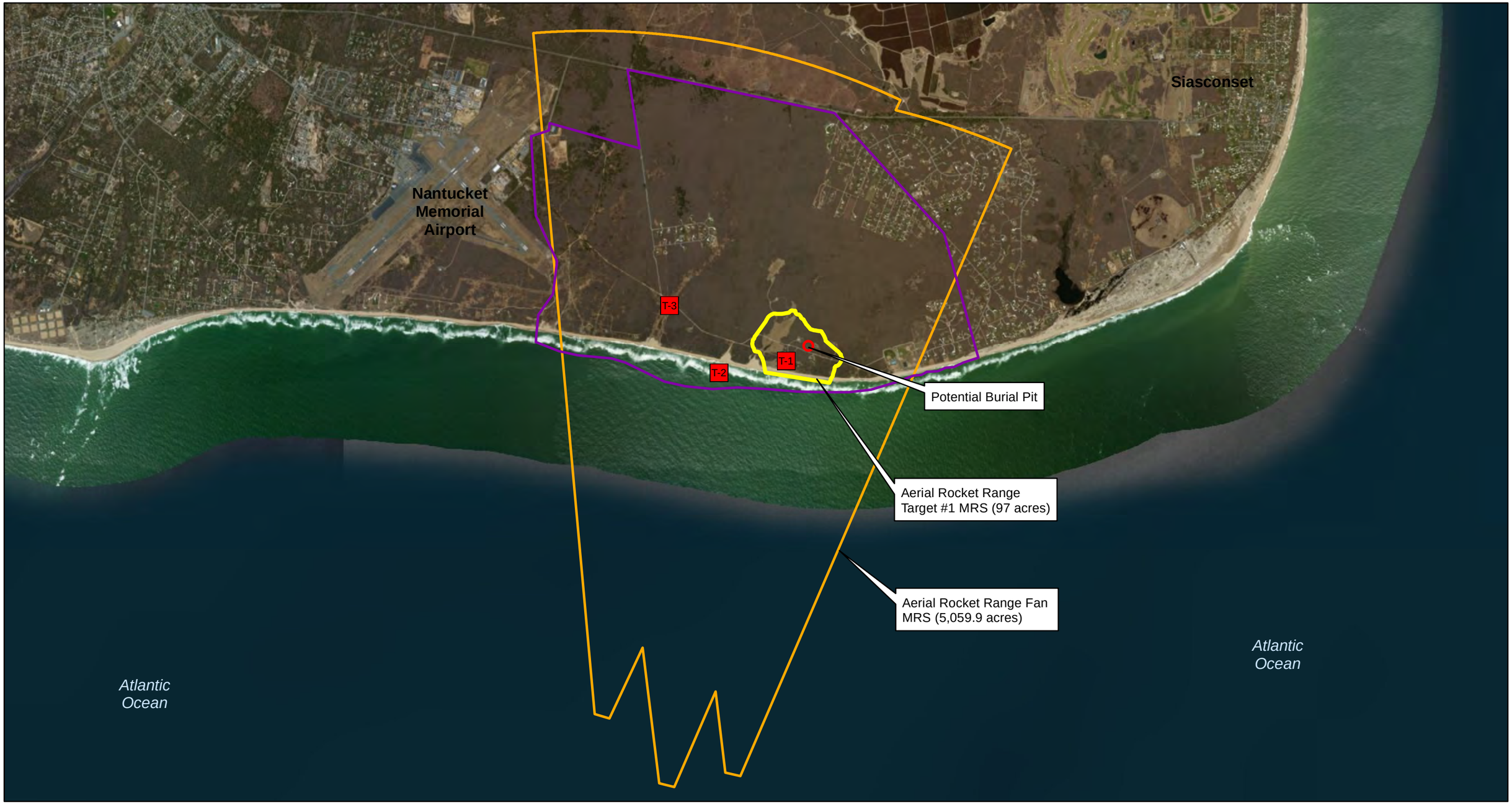
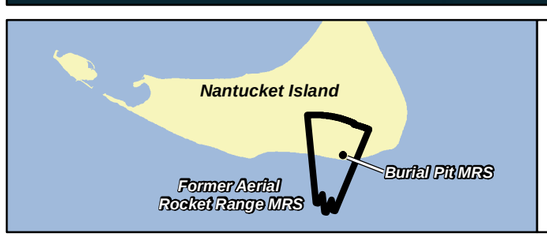
The MRS included the FUDS property (2,896 acres) where three potential former targets were used for aerial rocket training, a potential burial pit location, and the range fans depicted for all three targets including area extending into the Atlantic Ocean. The 97-acre Aerial Rocket Range Target #1 MRS boundary was delineated following the RI to separate the portion of the MRS where munitions debris (MD) was characterized and munitions have been historically discovered, from the remaining area (5,059.9 acres) as depicted on **Figure 1-3**. The Aerial Rocket Range Target #1 MRS of 97 acres was recommended for an FS and continued tracking under the FUDS Identification Number of D01MA045601R01. The remaining 5,059.9 acres was identified as the Aerial Rocket Range Fan MRS and recommended for no action following the RI based on the lack of munitions and explosives of concern (MEC) or MD discovered (WESTON, 2013).

The RI/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 was performed to be consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the U.S. Environmental Protection Agency (EPA) document, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA, 1988).

1.1 PURPOSE

The purpose of the FS for the Aerial Rocket Range Target #1 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 MRS. The selected alternatives are expected to mitigate, reduce, or eliminate unacceptable risks to human health and the environment from MEC at this FUDS, based on the current and intended future use of the property.





T-X T(Former Target Location)-X(Target No.)

Potential Burial Pit

Aerial Rocket Range Fan MRS Boundary

Aerial Rocket Range
Target #1 MRS Boundary

FUDS Boundary

Coordinate System:
UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach
Formerly Used
Defense Site

N

0 1,900 3,800 5,700 Feet

0 720 1,440 2,160 Meters

NOTES:
Aerial Data Source: ESRI iCubed Imagery Prime World 2D (2004)
Base Data: USACE (2004)

FIGURE 1-3
FUDS and MRS Boundaries
Nantucket, MA

6/11/2014	NT_FUDS_MRS_2V
Drawn: johna	PROJ: 03886.551.004

The FUDS program only applies to properties that transferred from DoD before 1986. The Army is the executive agent for the FUDS program, and USACE is the program's executing agent. USACE must comply with the Defense Environmental Restoration Program (DERP) statute [10 United States Code (USC) § 2701 et seq.], CERCLA (42 USC § 9601 *et seq.*), Executive Orders 12580 and 13016, the NCP, and all applicable DoD (e.g., EP 1110-1-18, ER 200-3-1, DoD *Management Guidance for the DERP* [9 March 2012]) and Army policies in managing and executing the FUDS program (USACE, 2004). The FUDS program addresses MEC, including unexploded ordnance (UXO), discarded military munitions (DMM), and munitions constituents (MC) located on former defense sites under the MMRP, established by the U.S. Congress under DERP.

Based on the results of the RI, no UXO or DMM were identified at this MRS that would be considered MEC. However, a significant amount of MD was delineated during characterization in the vicinity of former Target #1. An FS was recommended following the RI to address the 97-acre Aerial Rocket Range Target #1 MRS (WESTON, 2013).

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

- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and to be considered (TBC) information (Section 2).
- Identification of RAOs (Section 3).
- Identification of general response 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 RAO through a comparative analysis of all remedial alternatives using the NCP criteria (Section 5).

1.2 HISTORICAL INFORMATION

The Nantucket Beach FUDS was leased by the U.S. Government between September 1943 and 30 June 1946, and was used as a practice aerial rocket range. Training ceased on 1 September 1945. This was one of the three ranges on Nantucket used by the Navy pilots out of the Quonset Naval Air Station for training purposes. The Aerial Rocket Range and a potential 1.5-acre burial pit area located within the range were first identified via the Archives Search Report (ASR) prepared by USACE in September 1997. Since that time, multiple investigations to identify historical uses and potential residual impacts have been conducted including record searching, anecdotal information collection, the Site Inspection (SI) conducted in 2010, a clearance under private contract on a residential parcel (2011), and the RI completed in 2012 (WESTON, 2013).

Army documentation issued for this FUDS and reviewed during the SI through RI/FS process includes:

- USACE. 1995. Inventory Project Report for Nantucket Ordnance Site, DERP-FUDS Site D01MA0456, Nantucket, Massachusetts. July 1995.
- USACE. 1997. ASR Findings for the former Nantucket Ordnance Site (Tom Nevers Area), Project Number D01MA045601, Nantucket Island, Massachusetts. September 1997.
- USACE. 2009. ASR Supplement, Nantucket Beach, 2009.

Investigation documentation completed for the Army includes:

- Human Factors Applications, Inc./TerranearPMC, LLC (HFA). 2011. *Final Site Inspection Report for Nantucket Beach.* DERP FUDS Project No.: D01MA045601. April 2011.
- WESTON. 2013. *Final Remedial Investigation Report for the Nantucket Beach, Former Nantucket Ordnance Site A.K.A. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site, Prepared for the U.S. Army Corps of Engineers (USACE), Baltimore District, Baltimore, Maryland*.

Other investigation documentation completed by VRHabilis, LLC (VRHabilis) for private property owner in the vicinity of Target #1 includes:

- VRHabilis, 2011. *Final Site Specific Final Report* for Southeast Quarter Project, Nantucket, Document No. NA 01-1210C, Nantucket, Massachusetts. May 2011.

1.2.1 Munitions Response Site Background

The FUDS property consists of 2,896 acres located on the southeastern side of Nantucket Island in what is referred to as the Tom Nevers area in Nantucket, Nantucket County, Massachusetts (see **Figure 1-1**). The island of Nantucket is approximately 48 square miles and runs 14 miles east to west and 3.5 miles north to south. It can be accessed via ferry or airplane and is approximately 45 miles from Hyannis, Massachusetts and 30 miles from Falmouth, Massachusetts. During historical training exercises, pilots fired air-to-ground rockets at three potential ordnance sites (designated Target #1, Target #2, and Target #3) identified via historical records and imagery. Historical records regarding range structures and their intended purposes (i.e., main firing target, markers, glide indicators, etc.), potential improvements, and total number of targets/structures used during training exercises are unclear (WESTON, 2013).

Remnants of structures located at potential Target #1 and Target #3 were located on land by the ASR USACE site visit team in 1996. Target #2 was not located during the ASR as it was underwater due to the significant coastal erosion that has occurred since active use of the range. Historical photographs of the area indicate that Target #2 was evident on land through 1970, but had eroded into the ocean by the time the next available photograph was reviewed from 1978. (USACE, 1997)

1.2.1.1 Site Inspection

Prior to the RI, historical records review and field investigations were performed as part of the SI phase of activities. Munitions-related material discovered by the public has been historically responded to by Explosives Ordnance Disposal (EOD) and local emergency officials in the vicinity of Target #1 in accordance with USACE recommendation to recognize, retreat, and report (a.k.a., the 3Rs). The SI references two EOD incident reports that occurred in April 2010 (EOD, 2010a; and EOD, 2010b) after the field work was completed for that investigation. The

EOD incident reports from April 2010 state that high explosive (HE) rockets were recovered and these reports were subsequently reviewed by USACE. Due to the mission of the EOD to render items safe by detonation (as opposed to perforating the items to first determine whether the items contain explosives) coupled with the large amount of explosives used by the EOD team, USACE has concluded that it is highly unlikely and extremely difficult to determine if an item was MD or MEC after detonation (WESTON, 2013).

Field activities included a qualitative reconnaissance using a Schonstedt magnetometer, but no intrusive investigations were performed. A borehole gradiometer was used for underwater anomaly detection applications. Although no MEC was identified, 532 subsurface anomalies were detected. Additionally, MD was observed in the vicinity of Target #1. The MD included one empty, 3.5-inch rocket warhead, three 3.5-inch rocket heads, and one empty 2.25-inch practice rocket. One cylindrical item (tapered on one end) approximately 2.25 inches in diameter and 35 inches long was also found in addition to four partially-exposed ferrous items that could not be positively identified. (HFA, 2011)

MC samples collected during the SI were analyzed for project-specific explosive chemicals through EPA Method 8330A and metal analytes through EPA Method 6010C. A total of 11 surface/subsurface soil samples were collected. Sample locations were selected in a biased manner based on field detections of surface/subsurface anomalies, records of former target locations, or where past soil disturbance or likely areas for soil accumulation/deposition were observed (e.g., ground surface depressions). Explosives and metals were detected within soil, but not at hazardous levels. Five metal analytes (aluminum, barium, iron, magnesium and zinc) and nitroglycerin were detected in soil. Zinc was detected at a concentration of 50 milligrams per kilogram (mg/kg) in one surface soil sample, above its interim ecological screening level (46 mg/kg); however, no human health screening levels were exceeded. Nitroglycerin was detected at a concentration of 8.9 mg/kg in one subsurface sample, which exceeded all screening levels, including the residential exposure screening level of 0.61 mg/kg. Only iron in subsurface soil was detected in excess of its residential screening level (5,500 mg/kg), at a concentration of 6,700 mg/kg. Although the screening level evaluation identified zinc as a chemical of potential ecological concern (COPEC) for surface soil, and iron and nitroglycerin as chemicals of potential

concern (COPC) in subsurface soil, the risk evaluation did not determine that exposure to these constituents represented an unacceptable risk to receptors. Multiple lines of evidence were used to make this determination, such as a low frequency of detection/screening level exceedances observed site-wide, and in the case of iron, the analyte is not a hazardous substance defined under CERCLA. (HFA, 2011)

Groundwater samples collected from four residential drinking water wells within the MRS during the SI did not detect any explosive compounds. The well locations were selected from residents in the vicinity of former targets and where munitions had been discovered previously based on historical records. Perchlorate was detected at an estimated concentration of 0.02 micrograms per liter (µg/L) (below laboratory quantitation limits), which is two orders of magnitude below the human health screening level. (HFA, 2011)

Two sets of co-located sediment and surface water samples were collected in the vicinity of former potential targets on land. No explosive compounds were detected in sediment samples. All detected metal analytes in sediment were observed at concentrations less than human health and ecological screening levels. Similarly, no explosive compounds were detected in surface water. Except for aluminum, all detected metal analytes were observed at concentrations below the project screening levels. The estimated concentrations of aluminum in all three surface water samples (results between 200 and 260 µg/L) exceeded the interim ecological screening level of 87 µg/L, but not the human health level (37,000 µg/L). Although aluminum was determined to be a COPEC for surface water based on the screening level evaluation, exposure was not considered to represent an unacceptable risk to receptors because the analyte is not a hazardous substance defined under CERCLA. (HFA, 2011)

Although MD was observed near Target #1, the nature and extent of MEC and MD was not fully understood following the SI. Based on the potential for a MEC burial scenario and use as a former rocket range, the MEC source would be expected to be found on the ground surface and/or subsurface soils. The MEC source may also have been underwater at Target #2 and along the shoreline spanning the MRS. Potentially complete pathways for both MEC and MC were

identified in the preliminary Conceptual Site Models (CSM) developed following as part of the SI Report. The SI recommended proceeding to RI/FS with a focus on MEC. (HFA, 2011)

Based on the results of the SI, the Aerial Rocket Range was conservatively realigned to include 5,157 acres of land and coastal water which encompassed all three potentially used targets and the 1.5- acre potential burial pit area.

1.2.1.2 Clearance under Private Contract

VRHabilis performed a clearance under contract with a private owner to identify and remove material potentially presenting an explosive hazard (MPPEH) from Parcel No. 90 9 between 1 February 2011 and 16 March 2011. As part of the clearance, a total of 6 acres were geophysically mapped to detect anomalies and intrusively investigated (clearance area depicted on **Figure 1-4** and **Figure 1-5**). The *Site Specific Final Report*, documents completion of the clearance which includes the removal and disposal of 178 MD items totaling 1,200 pounds, turnover of approximately 1,500 pounds of material documented as safe (MDAS), and 500 pounds of cultural debris. Munitions Debris that were recovered and removed included: 2.25-inch sub-caliber aircraft rockets (SCAR); 5-inch high velocity aircraft rockets (HVAR); 3.5-inch forward firing aircraft rockets (FFAR); 90-millimeter armor piercing warheads; and a 2.25-inch solid steel warhead (VRHabilis, 2011). Based on USACE receipt of 13 March 2013 V.R. Habilis acknowledgement, "No MEC was found during the Removal Action performed by V.R. Habilis and all MD items were found to be inert and disposed of by V.R. Habilis. All MEC items referenced in the *Site Specific Final Report* should be correctly referred to as Munitions Debris."

1.3 SUMMARY OF REMEDIAL INVESTIGATION RESULTS

This section provides a summary of the results of the RI conducted to characterize the MRS and determine the nature and extent of MEC hazards and/or MC risks. Field activities were conducted between 01 March and 31 August 2012, at the MRS to achieve the project Data Quality Objectives established in the *Final Work Plan* (WESTON, 2012), and to determine if further action is required under the CERCLA process. Incomplete exposure pathways for MEC and MC for human health and ecological receptors were identified following the RI due to the

lack of UXO or DMM discovered. No significant detections of MC have been observed in environmental media, and no MC risks associated with MD delineated at the MRS were identified for potential receptors during the human health or ecological risk assessments (WESTON, 2013).

The characterization of nature and extent of practice munitions at the MRS from data collected through the RI serves as the basis for future remedial decision making at the MRS. Should new data be obtained in the future that is contrary to the baseline assessment of hazards and risks established during the RI, such as the discovery of MEC, a reassessment of current conditions and actions will be warranted. The results of the RI are fully reported in the *Final Remedial Investigation Report, Nantucket Beach, Former Nantucket Ordnance Site A.K.A. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site, Nantucket, MA* (WESTON, 2013).

1.3.1 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.
  - 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).

Munitions constituents refer to any materials originating from MEC; DMM; or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such munitions (DoD, 2008).

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

A Wide Area Assessment (WAA) survey utilizing an airborne vertical magnetic gradient system was performed over an area of 2,480 acres which encompassed land and near shore portions of the Aerial Rocket Range, including the potential burial pit area. The purpose of the WAA survey was to locate areas exhibiting elevated anomaly densities which are indicative of potential MEC impact areas. One anomaly cluster, AC-01, was identified where munitions have previously been discovered and in close proximity to the Target #1. The WAA analysis, coupled with historical information (i.e., documents, records, aerial photos), resulted in the identification of 10 anomaly clusters in total that warranted further investigation. (WESTON, 2013)

Within the 10 anomaly clusters, a total of 23.55 acres were surveyed using ground-based geophysical methods during the RI. Additionally, 1.04 acres of underwater mag & dig surveys were performed. A total of 1,304 anomalies were intrusively investigated. No UXO was recovered during any RI intrusive investigations. A total of 938 MD items (18,140 pounds in volume) were recovered on the ground surface and in the subsurface to a depth of 8 feet (ft) below ground surface (bgs) within AC-01 during the RI. No evidence of DMM or hazardous and toxic waste burial was observed within the potential burial pit area. No MEC or MD was discovered in anomaly clusters other than AC-01 or during the underwater survey effort. (WESTON, 2013)

The information and data collected through the RI indicates that only one of the three potential former targets, identified in historical documents as Target #1, has been confirmed to have been actively used. Based on the WAA survey results, digital geophysical mapping (DGM) surveys, intrusive investigations, distribution of MD, and previous studies performed at the MRS, the size of the Target #1 footprint area was delineated in lateral extent to encompass 97 acres. Within this

97-acre boundary, residual MD is present at densities equal to or greater than 0.1 MD per acre. No MEC or MD was discovered beyond this boundary during the RI (WESTON, 2013). The following subsection details the nature and extent of MD discovered during the RI.

1.3.1.1 Nature and Extent of Munitions Debris

The following 938 individual MD items were recovered during the RI in total:

- 67 – 5-inch HVARs
- 302 – 3.5-inch FFARs
- 326 – 2.25-inch SCARs
- 242 – miscellaneous rocket components
- 1 – fragment (determined to be present from prior demilitarization operations)

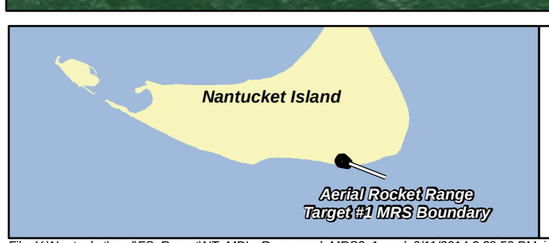
All MD was recovered and ultimately classified as MDAS. Historical reports of suspect HE munitions that have been found or demolished within the MRS were not confirmed as no UXO was observed during the RI. A figure depicting the type and location of MD recovered during the RI is included as **Figure 1-4**. The density of MD characterized within AC-01 was modeled using Visual Sample Plan (PNNL, 2011) as depicted on **Figure 1-5**. This figure depicts the revised MRS boundary line encompassing an area of 97 acres around the former Target #1 footprint, which captures all MD delineated within the MRS during the RI. No evidence of munitions was found beyond this demarcation. A summary of the MD recovered during the RI with an estimate of the total quantity of MD present within the 97-acre boundary line is presented on **Table 1-1.** (WESTON, 2013)

Highlighted on **Figure 1-5** is a 6-acre portion of AC-01 that was previously subject to a clearance under private contract by the residential parcel owner (VRHabilis, 2011). Review of the report generated for the private client indicates that all items removed during this action were also found to be inert. Additional clearance activities have been undergone by this property owner since the time the RI was completed in 2012; however, the area addressed and results of these activities have not yet been made available to USACE.

The average depth of recovered items was 2.5 ft, with a median depth of 3 ft based on the 938 recovered items. The maximum depth of recovered MD in this MRS was 8 ft (2.25-inch SCAR in grid AC-01-G02). A total of 110 contacts were left in-place within the AC-01 investigation area and not intrusively investigated. Given the location of these residual contacts within the

high anomaly density areas mapped as AC-01, it is assumed that the location and nature of these items are most likely similar to the inert MD recovered during the RI. (WESTON, 2013)

In both grids, AC-01-G04 and AC-01-G08, contacts were left in-place at depths greater than 4 ft bgs as the depth of MD is likely similar to that observed in AC-01-G02 given the similar density of anomalies mapped in these grids. A total of 77 contacts were left in grid AC-01-G04, and 13 contacts were left in grid AC-01-G08. Additionally, on transect AC-01-T03, contacts were left in-place at depths greater than 2 ft bgs due to the transect's close proximity to the beach bluff and fragile stability of soils and vegetation. To preserve the integrity of the bluff, 18 contacts were left in-place within AC-01-T03. Grid AC-01-G01 was positioned within a figure depicting the depth of MD items recovered during the RI is provided as **Figure 1-6** for the MRS. Inset D is provided on **Figure 1-6** to detail the depth of MD recovered from grid AC-01-G12, which was located in close proximity to the potential burial pit being investigated. Although MD was recovered from this grid at depths up to 5 ft bgs, the clustering of MD delineated within this grid was determined not to be representative of a burial pit. (WESTON, 2013)



T-1 Former Target
2.25-in rocket
3.5-in rocket
5-in rocket
Frag
Other MD

DGM Transect
DGM Grid
Anomaly Cluster (From VSP)
Aerial Rocket Range Target #1 MRS Boundary
Potential Burial Pit
Area previously cleared under private contract

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

WESTON SOLUTIONS

FIGURE 1-4
Nature and Lateral Extent of MD

N
0 190 380 570 Feet
0 70 140 210 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS
Base Data: USACE (2004)
Coordinate System:
UTM, Z19N, NAD83, US Foot

6/11/2014 | NT_MD's_Recovered_MRS2_1

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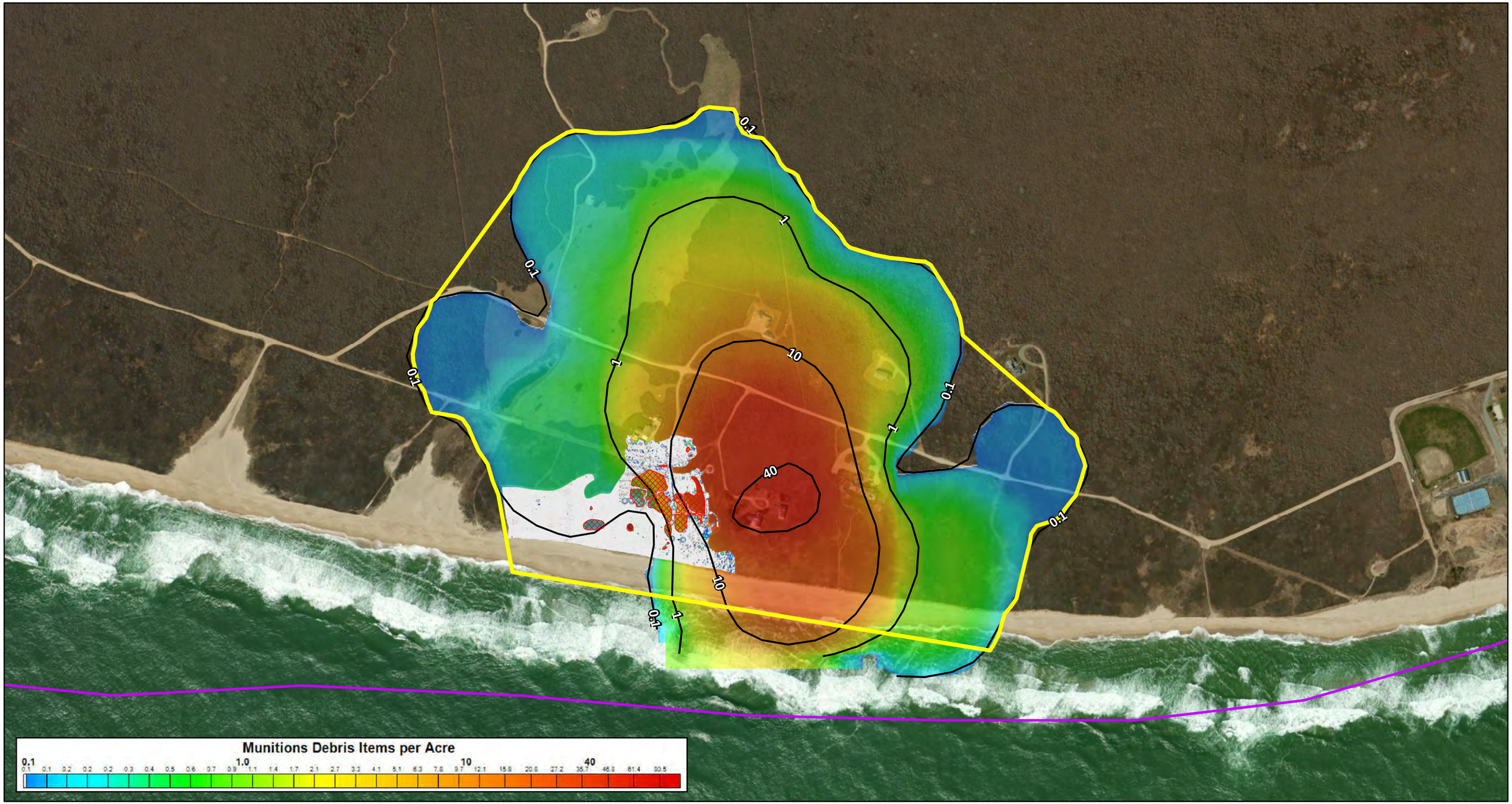

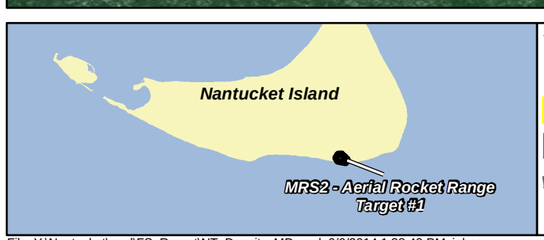

Anomaly Density Contour
Areas Not Investigated
Aerial Rocket Range Target #1 MRS Boundary
FUDS Boundary
Area previously cleared under private contract

Coordinate System: UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

WESTON SOLUTIONS

FIGURE 1-5
Munitions Debris Density

N

0 250 500 750 Feet

0 90 180 270 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004)

6/6/2014 | NT_Density_MD

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Map Inset D

AC-01-G12

0 30 60 90 Feet
0 8 16 24 Meters

AC-01-T14

0.1

AC-01-T13

AC-01-G20

AC-01-T12

AC-01-T11

AC-01-G19

AC-01-G18

AC-01-G17

AC-01-T10

AC-01-G15

AC-01-G14

AC-01-G16

AC-01-G13

AC-01-T09

See Map Inset D

AC-01-T08

AC-01-T07

AC-01-G10

Potential Burial Pit

AC-01-G11

See Map Inset C

AC-01-T05

See Map Inset A

AC-01-G05

AC-01-G06

T-1

AC-01-G21

AC-01-T16

AC-01-T04

AC-01-G01

AC-01-G07

40

See Map Inset B

AC-01-T01

AC-01-T02

AC-01-T15

AC-01-T03

AC-01-G03

10

0.1

1

Map Inset A

AC-01-T06

AC-01-G08

AC-01-G04

0 30 60 90 Feet
0 10 20 30 Meters

Map Inset C

AC-01-T06

AC-01-G09

0 100 200 300 Feet
0 25 50 75 Meters

Map Inset B

AC-01-G02

0 30 60 90 Feet
0 10 20 30 Meters

Nantucket Island

MRS 2 - Aerial Rocket Range Target #1

MD Depth Contour
Depth in Inches
-108 to -96
-96 to -84
-84 to -72
-72 to -60
-60 to -48
-48 to -36
-36 to -24
-24 to -12
-12 to 0

Former Target
DGM Grid
DGM Transect
Anomaly Density Contour
Potential Burial Pit
Aerial Rocket Range Target #1 MRS Boundary

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

WESTON SOLUTIONS

FIGURE 1-6
Depth Extent of MD Recovered

N

0 190 380 570 Feet
0 70 140 210 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004)

6/6/2014 | NT_md_depth_MRS2_1

Drawn: johna | PROJ: 03886.551.004

Table 1-1
Estimated Quantity of Munitions Debris

MD Density Interval (MD per acre) (see Figure 1-5)	Total Area (acres) in Density Interval	Total Area (acres) Investigated	Quantity of MD Recovered during RI	Depth Range of Recovered MD	Estimated Quantity of MD (items) Remaining [1]
< 1	55.9	2.9	2.5-inch: 6 items 3.5-inch: 5 items 5-inch: 1 item Frag: 1 item[2] Other MD: 0 items	2.5-inch: 12 in to 36 in bgs 3.5-inch: 0 in to 4 in bgs 5-inch: 6 in bgs Frag: 6 in bgs Other MD: NA **Range: 0 in to 36 in bgs**	238
1-10	23.0	1.2	2.5-inch: 25 items 3.5-inch: 8 items 5-inch: 4 items Frag: 0 items Other MD: 0 items	2.5-inch: 0 in to 60 in bgs 3.5-inch: 3 in to 48 in bgs 5-inch: 0 in to 24 in bgs Frag: NA Other MD: NA **Range: 0 in to 60 in bgs**	672
10-40	16.3	1.4	2.5-inch: 286 items 3.5-inch: 284 items 5-inch: 60 items Frag: 0 items Other MD[3]: 239 items	2.5-inch: 0 in to 96 in bgs 3.5-inch: 0 in to 72 in bgs 5-inch: 0 in to 72 in bgs Frag: NA Other MD[3]: 0 in to 51 in bgs **Range: 0 in to 96 in bgs**	9,253
40+	1.8	0.006	2.5-inch: 9 items 3.5-inch: 5 items 5-inch: 2 items Frag: 0 items Other MD[3]: 3 items	2.5-inch: 6 in to 60 in bgs 3.5-inch: 6 in to 30 in bgs 5-inch: 48 in to 60 in bgs Frag: NA Other MD[3]: 6 in to 60 in bgs **Range: 0 in to 96 in bgs[4]**	5,569
Totals	**97.0**	**5.5**	**938**		**15,731**

Notes:
bgs = below ground surface
in = inches
MD = munitions debris
MRS = Munitions Response Site
RI = Remedial Investigation

[1] Estimated quantity of MD (partial or intact practice rockets) generated using RI intrusive investigation results [See Final RI Report (WESTON, 2013) Appendix G - Target Dig List for AC-01] to calculate density as MD items per acres investigated, which was uniformly applied to area within contours modeled for the 97-acre impact area using VSP (see Figure 1-5) to simulate MD spatial distribution. Individual MD items removed from the MRS during the RI were also removed from the estimated quantities shown for each contour interval of similar MD densities.

[2] Recovered item classified as a rocket fragment was determined in the field by the Senior Unexploded Ordnance Supervisor to be associated with a historical demilitarization operation performed by EOD or other responsible organization.

[3] Other MD indicates miscellaneous, inert rocket components.

[4] Contacts were left in-place during the RI at depths greater than 48 inches bgs in the 40+ MD/acre density interval; assumed maximum range in depth is equal to 96 in bgs based on RI findings in Grid AC-01-G02.

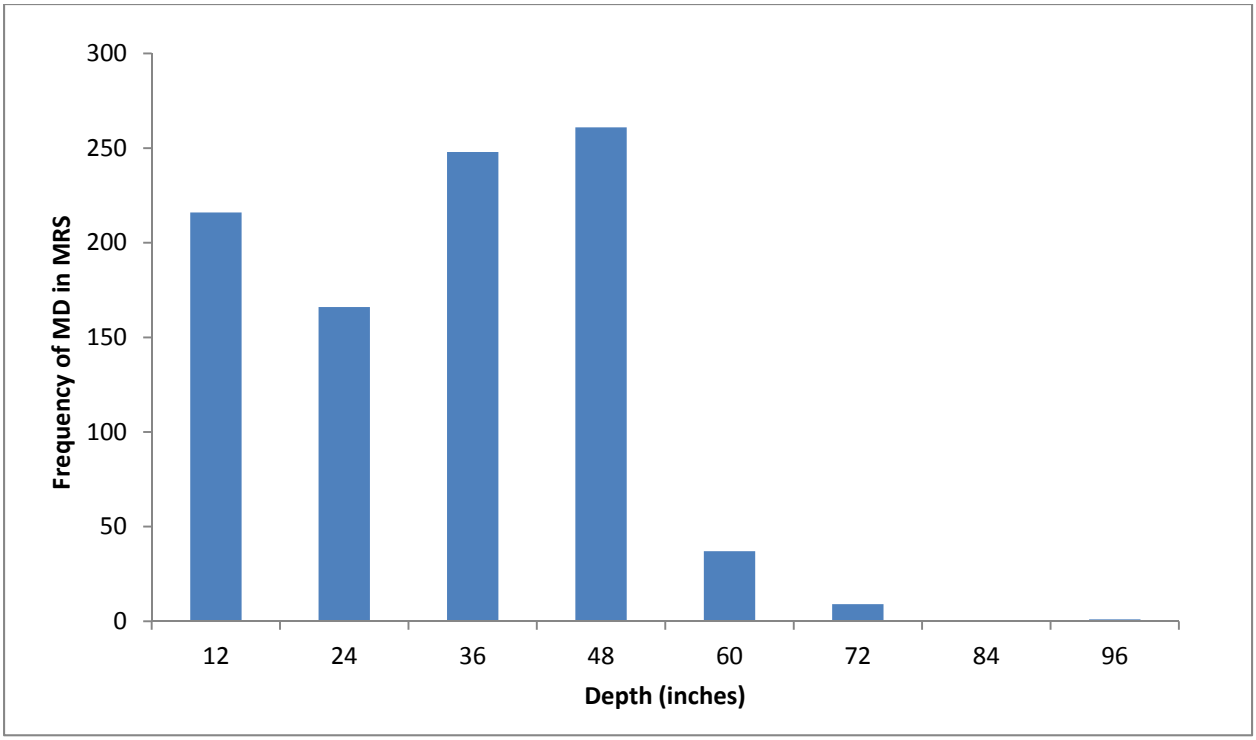
Table 1-2 below has been provided to summarize the distribution of MD within the MRS that was characterized during the RI, and **Figure 1-7** provides a histogram of the RI results that plots the total frequency of recovered MD against the depth of each finding in inches below ground surface.

Table 1-2 MRS Munitions Debris Depth Distribution

Depth (inches below ground surface)	Munitions Debris Type				Total
	2.25-inch SCAR	3.5-inch FFAR	5-inch HVAR	Miscellaneous Components	
0 - 12	88	56	18	54	216
12 - 24	35	47	17	67	166
24 - 36	80	90	18	60	248
36 - 48	97	94	10	60	261
48 - 60	21	11	3	2	37
60 - 72	4	4	1	0	9
72 - 84	0	0	0	0	0
84 - 96	1	0	0	0	1
					938

Notes:
Munitions debris recovered during 2012 Remedial Investigation
SCAR = sub-caliber aircraft rocket
FFAR = forward firing aircraft rocket
HVAR = high velocity aircraft rocket

Figure 1-7 MRS Munitions Debris Depth Profile



During the RI, only 3 percent (%) of the total quantity of MD recovered was discovered at ground surface. The remaining subsurface MD that was discovered within the investigated portion of the MRS was primarily located within 4 ft of ground surface.

To supplement the observations made during the RI, the maximum possible penetration depth for the types of munitions at the MRS was assessed. Calculations were performed considering the soil conditions and MD identified during the RI. Based on the most conservative estimate that could be assessed, the maximum possible depth that MD may be present within the MRS boundary is 12.5 ft bgs based on input data for the 5-inch HVAR (WESTON, 2013).

As shown on **Figure 1-4**, all recovered MD was concentrated in the vicinity of former Target #1 in the investigation area demarcated as AC-01. The amount of MEC characterization (DGM and intrusive work) performed in AC-01 met the UXO Estimator performance requirements established for the RI. The statistical upper bound density of MEC was determined to be 0.443 MEC per acre based on the percentage of area surveyed at the MRS, and the actual intrusive investigation results. This value was within the data quality objective (DQO) maximum

target density of 0.5 MEC per acre which means that the investigation was adequate to be 95% confident that there is less than 0.443 MEC per acre within AC-01/Target #1. Although the UXO Estimator results indicate that a statistical potential for MEC may remain at the MRS; no UXO or DMM have been found, and it is anticipated that no MEC source or explosive safety hazard is present. (WESTON, 2013)

1.3.1.2 Munitions Constituents

Due to the high concentration of MD located at AC-01/Target #1, MC sampling was performed even though a MEC source was not detected, to support baseline risk assessment during the RI. Samples collected were submitted for laboratory analysis of explosives through EPA Method 8330B and metals through EPA Method 6010C. Five surface soil samples were collected using Incremental Sampling Methodology from geophysical investigation grids where the highest concentrations of MD were observed during the RI. In addition, soil sampling was performed in biased locations within each of these grids where the highest density of subsurface MD was observed using discrete grab samples to profile subsurface soil to 10 ft bgs. A total of 15 discrete samples were collected. Groundwater was also sampled for MC. Groundwater was sampled directly from the four residential wells located within the MRS that are known drinking water supplies for both full-time and seasonal residents. (WESTON, 2013)

Non-detects for explosives in subsurface soil samples and groundwater samples were reported at concentrations less than the project's risk-based screening levels. Perchlorate was detected at an estimated concentration of approximately 0.02 µg/L in all four groundwater wells, which was consistent with previous findings during the SI and significantly below the project screening criterion of 2 µg/L. Several low level detections of explosives were reported at estimated concentrations in the incremental surface soil samples, but the results and limit of quantitation for analysis reported by the laboratory were below the project screening levels. Detections of metals in soil and groundwater were below project screening levels and/or consistent with expected background concentrations. No COPCs or COPECs were identified during the risk evaluation. (WESTON, 2013)

Munitions constituents assessed in soil and groundwater in the areas of increased MD densities observed during the RI were not found to pose any adverse risk to human health or the environment as indicated by the human health and ecological risk assessments. Incomplete pathways for MC exposure were identified for the updated CSM due to a lack of confirmed source. (WESTON, 2013)

1.3.1.3 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. No UXO or DMM were identified during the SI or RI field activities which have been interpreted to indicate that no MEC source or explosive safety hazard is present at the MRS. As a result, the project team determined that calculation of a MEC HA score was not warranted for the MRS (WESTON, 2013).

1.3.2 Environmental Setting

1.3.2.1 Climate

The MRS is located on Nantucket Island, which is surrounded by Nantucket Sound to the north and the Atlantic Ocean to the south. Nantucket Island is located southeast of the mainland of Massachusetts, south of Cape Cod. The Atlantic Ocean, the prevailing east to west air masses (causing storms), and low pressure storm systems are the three major influences to the climate at the MRS. The temperature is moderate due to the proximity of the MRS to the Atlantic Ocean, and there is an adequate amount of rain fall due to the low pressure storm systems. The hottest month is July with an average temperature of 73.5 degrees Fahrenheit (°F), and the maximum temperature on record is 102°F in July 1977. The coldest month of the year is January with an average daily temperature of 29.6°F. The minimum temperature on record is -12 °F in January 1957. Local rainfall is distributed throughout the year with the highest precipitation occurring in

December (averaging 4.5 inches) and the lowest during June (averaging 2.9 inches). The total annual precipitation in this area averages approximately 43.81 inches. (USACE, 1997)

1.3.2.2 Geology

Nantucket Island, along with other nearby islands and the coastal region of Massachusetts subsumed as Cape Cod, were formed between 23,000 to 18,000 years ago as the last continental ice sheet to cover New England, known as the Laurentide, made its advance and retreat over the region and the rise in sea level that followed. Nantucket Island was formed at the edge of one of the ice sheet's lobes at a point of maximum advancement over the region, as indicated by gravel deposits on the continental shelf and by the outwash plains and moraines observed on the islands of Cape Cod. [U.S. Geological Survey (USGS), 2001]

1.3.2.3 Topography and Surface Features

The MRS is located on the southern coast of Nantucket Island in Nantucket County, Massachusetts. The elevation of the MRS property ranges from approximately 35 ft above mean sea level in the north and slopes toward sea level at the beach. A steep bluff (ranging from 5 ft to 20 ft tall) exists between the beach and the vegetated land boundary due to extensive and ongoing erosion. There are several wetland areas that are present near the ocean within the MRS. The topography of the land can be described as gently rolling moorlands with low-lying vegetation (scrub oak) and sandplain grasslands, dunes, and beach. A USGS map contouring topography within the MRS is provided as **Figure 1-8**. (WESTON, 2013)

The majority of the MRS is covered with scrub oak (*Quercus ilicifolia*), an intricately branched shrub that grows 8 to 10 ft tall, with holly-like leaves (HFA, 2011). Scrub oak is an extremely tough and resilient shrub that occurs along the south shore of the island between Nantucket Memorial Airport and the former Tom Nevers Naval Facility [Nantucket Conservation Foundation (NCF), 1999]. Several large grasslands (privately-owned), including a manicured lawn allowed access for use by a remote controlled airplane flying club, are present north and south of New South Road.

Aerial Rocket Range
Target #1 MRS Boundary

FUDS Boundary

Coordinate System:
UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach
Formerly Used
Defense Site

WESTON SOLUTIONS

FIGURE 1-8
Site Topography
Nantucket, MA

N

0 0.25 0.5 1 Kilometers

0 0.125 0.25 0.5 0.75 Miles

NOTES:
Source: National Geographic Society, i-cubed
Base Data: USACE (2004)

6/11/2014	NT_Site_Topo
Drawn: johna	PROJ: 03886.551.004

1.3.2.4 Soils

Soil at the site is comprised of glacial outwash gravelly sands. A U.S. Department of Agriculture soil survey conducted in 1979 mapped soil within the borders of the MRS as either part of the Evesboro or River-head Katama Association. Both soil units are described as being nearly level, well, to excessively-drained outwash deposits (U.S. Department of Agriculture, 1979). Previous site reports indicate that the surface soil is brown and yellowish brown sand found to 26 inches bgs. The subsoil layer is found to a depth of 60 inches bgs and is light yellowish brown sand. (USACE, 1997)

Observations of soil characteristics made during intrusive investigations conducted to support the RI in the MRS were consistent with these descriptions. A thin layer of dark brown topsoil (silty sand with organics) was observed overlying brown/orangish brown, well-graded sands and gravel of fine to coarse grain size to approximately 4 ft bgs. Clearly defined, well-graded, stratified drift material (yellowish brown medium to coarse gravelly sands with fine black sand) was encountered in bedded layers at depths averaging 4 ft bgs in all excavations. Pockets/bedded layers of highly oxidized medium-grain sized orangish brown sand were observed throughout the study area. No silty sands or clays were observed at depths below the topsoil layer.

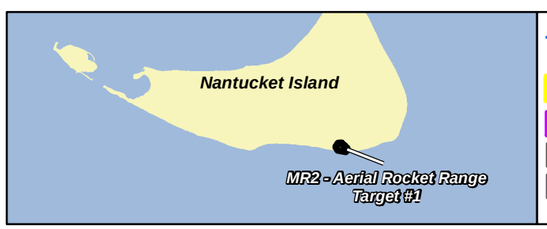
1.3.2.5 Hydrogeology

1.3.2.5.1 Surface Water and Wetlands

There are several wetland areas within the MRS that drain into the Atlantic Ocean. To determine the potential for wetlands and water resources within the MRS, the current Massachusetts Geographic Information System (MassGIS) wetland resources and hydrology layers were obtained for the project areas (WESTON, 2012). **Figure 1-9** illustrates the wetlands habitats associated with the MRS.

The excessively drained soils that comprise the majority of Nantucket Island in general and the MRS in particular result in very few wetlands. According to National Wetlands Inventory maps, wetlands in the vicinity of the MRS are limited to the area near the shoreline, comprising a few relatively small palustrine or estuarine areas, and a narrow band of generally unvegetated marine wetlands along the shoreline. The extent of wetlands within the MRS comprises 8% of the total area of MRS [U.S. Fish and Wildlife Service (USFWS), 2010]. A stream crosses through the MRS but was not observed with flowing water except within wetland region demarcated on **Figure 1-9**. **Table 1-3** provides a description of the wetlands at the MRS.

NOTES:
Aerial Data Source: ESRI iCubed Imagery Prime World 2D (2004) Base Data: USACE (2004); U.S Fish and Wild Services, NWI.
GW Flow Data: USGS (U.S. Geological Survey). 1997. Effects of Simulated Ground-Water Pumping and Recharge on Groundwater Flow in Cape Cod, Martha's Vineyard, and Nantucket Island Basins, Massachusetts, 1997.



DEP Rivers and Streams
Aerial Rocket Range Target #1 MRS Boundary
FUDS Boundary
Estuarine and Marine Wetland
Freshwater Forested/Shrub Wetland
GW Flow Direction

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

WESTON SOLUTIONS

FIGURE 1-9
Wetlands and Surface Water Bodies

N

0 430 860 1,290 Feet

0 160 320 480 Meters

Coordinate System:
UTM, Z19N, NAD83, US Foot

6/11/2014 | NT_Wetlands

Drawn: johna | PROJ: 03886.551.004

Table 1-3 Wetlands Mapped Within the MRS

Wetland Type	Estimated Acres
A palustrine broad-leaved, deciduous/emergent, persistent, seasonally-flooded/saturated wetland (PSS1/EM1E) located along the western boundary of the MRS (Freshwater Forested/Shrub Wetland per **Figure 1-9**).	1.2
A marine intertidal, unconsolidated shore, sand, irregularly-flooded wetland (M2US2P) located within the intertidal zone along the beach line (Estuarine and Marine Wetland per **Figure 1-9**).	6.6

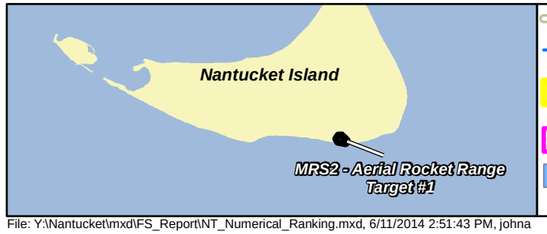
Notes: (USFWS, 2010)

Nantucket Island is affected by semidiurnal tides. The mean tidal heights are 0.14 ft at mean low water and 2.04 ft at mean high water. Typically, ocean currents flow to the south with average speeds of 0.5 knots in the summer and 0.7 knots in the winter. Average sea surface temperatures are 48 to 50°F in the summer and 40°F in the winter. (USACE, 1997)

1.3.2.5.2 Groundwater Use

There is public water service on the island provided by Wannacomet Water Company, however, the residences closest to the former targets use private groundwater wells. The current Numerical Ranking System map for the MRS depicts the entire former property within a designated EPA sole source aquifer as shown on **Figure 1-10** (MassGIS, 2012a). According to the MassGIS website, the MRS is not located within the Wannacomet Massachusetts Zone II Wellhead Protection Area (Mass Zone II WPA), which is delineated to the west of the MRS, or the Siasconset Mass Zone II WPA located east of the MRS. There are no interim WPAs within 2 miles of the MRS boundary. There are three WPAs that are located just west of the MRS, within 4 miles of the MRS boundary as shown on **Figure 1-11** (MassGIS, 2012b).

Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Siasconset
Nantucket Memorial Airport



Road
Surface Water Bodies
Aerial Rocket Range Target #1 MRS Boundary
Approved Wellhead Protection Area (Zone II)
Freshwater Pond
NHESP Estimated Habitat of Rare Wildlife
Potentially Productive High Yield Aquifer
FUDS Boundary

Coordinate System: UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 1,200 2,400 3,600 Feet

0 460 920 1,380 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004); U.S Fish and Wild Services, NWI

FIGURE 1-10
Numerical Ranking System Map

6/11/2014	NT_Numerical_Ranking
Drawn: johna	PROJ: 03886.551.004

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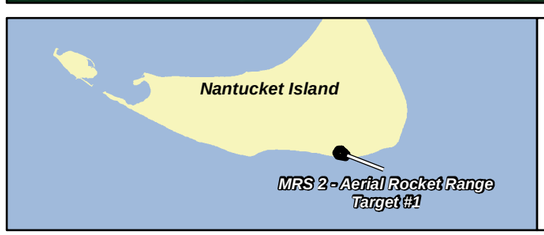
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd
Milestone Rd

Nantucket
Memorial
Airport



DEP Rivers and Streams
DEP Approved Zone IIs
FUDS Boundary
Aerial Rocket Range Target #1 MRS Boundary

Coordinate System:
UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 1,000 2,000 3,000 Feet

0 400 800 1,200 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004); U.S Fish and Wild Services, NWI

FIGURE 1-11
Massachusetts Zone II
Wellhead Protection Area

6/11/2014 | NT_Welhead_Protection

Drawn: johna | PROJ: 03886.551.004

1.3.2.6 Sensitive Species, Environments, and Environmental Resources

There are several sensitive environments present within the MRS. It is located within the Massachusetts Coastal Zone and includes two types of wetlands, including estuarine and marine wetlands and freshwater forested/shrub wetlands. Federally-listed threatened and endangered species, state-listed endangered species, state-listed threatened species, and state-listed special species of concern may be present (HFA, 2011).

Numerous natural resource agencies were contacted and coordinated through USACE including USFWS, U.S. National Marine Fisheries Service (NMFS), the Massachusetts Division of Fisheries & Wildlife, Natural Heritage and Endangered Species Program (NHESP) stakeholders during RI planning and implementation to identify potential impacted sensitive species. **Table 1-4** has been included to provide a list of all sensitive species of concern applicable to the MRS that were considered during the RI (WESTON, 2012). Specific species of concern that required monitoring, protection, and impact mitigation include nesting shorebirds (Piping Plovers, Roseate, and Least Terns), nesting Northern Harriers, and the American Burying Beetle.

Table 1-4 Federal- and State-Listed Endangered and Threatened Animal and Plant Species Found in the Vicinity of the MRS

Scientific Name	Common Name	State Protection Status
Mammals		
None		
Birds		
Charadrius melodus	Piping Plover	Federally and State Threatened
Sterna dougallii	Roseate Tern	Federally and State Endangered
Asio flammeus	Short-Eared Owl	State Endangered
Circus cyaneus	Northern Harrier	State Threatened
Sterna antillarum	Least Tern	State Special Concern
Tyto alba	Barn Owl	State Special Concern
Reptile & Amphibians		
Scaphiopus holbrookii	Eastern Spadefoot	State Threatened

Table 1-4 Federal- and State-Listed Endangered and Threatened Animal and Plant Species Found on in the Vicinity of the MRS (Continued)

Scientific Name	Common Name	State Protection Status
Fish		
None		
Invertebrates		
Nicrophorus americanus	American Burying Beetle	Federally and State Endangered
Cicinnus melsheineri	Melsheimer's Sack Bearer	State Threatened
Acronicta albarufa	Barrens Daggermoth	State Threatened
Catocala herodias gerhardi	Gerhard's Underwing Moth	State Special Concern
Zale sp 1 nr lunifera	Pine Barrens Zale	State Special Concern
Hemileuca maia	Barrens Buckmoth	State Special Concern
Bagisara rectifascia	Straight Lined Mallow Muth	State Special Concern
Cingilia catenaria	Chain Dot Geometer	State Special Concern
Metarranthis pilosaria	Coastal Swamp Metarranthis Moth	State Special Concern
Psectraglaea carnosa	Pink Sallow	State Special Concern
Chaetaglaea cerata	Waxed Sallow Moth	State Special Concern
Euchlaena madusaria	Sandplain Euchlaena	State Special Concern
Plants		
Ageratina aromatic	Lesser snakeroot	State Endangered
Agrimonia pubescens	Hairy Agrimony	State Threatened
Amelanchier nantucketensis	Nantucket Shadbush	State Special Concern
Amphicarpum amphicarpon	Annual Peanut-grass	State Endangered
Aristida purpurascens	Purple Needlegrass	State Threatened
Asclepias purpurascens	Purple Milkweed	State Endangered
Carex mitchelliana	Mitchell’s Sedge	State Threatened
Carex striata	Walter’s Sedge	State Endangered
Corema conradii	Broom Crowberry	State Special Concern
Crataegus bicknellii	Bicknell’s Hawthorn	State Endangered
Crocanthemum dumosum	Bushy Cockrose	State Special Concern
Dichanthelium dichhotomum ssp. Mattamuskeetense	Mattamuskeet Panic-grass	State Endangered

Table 1-4 Federal- and State-Listed Endangered and Threatened Animal and Plant Species Found on in the Vicinity of the MRS (Continued)

Scientific Name	Common Name	State Protection Status
Plants (continued)		
Dichanthelium ovale ssp. Pseudopubescens	Common's Panic-grass	State Special Concern
Elatine Americana	American Waterwort	State Endangered
Eleocharis tricostata	Three-angled Spike-sedge	State Endangered
Gamochaeta puppurea	Purple Cudweed	State Endangered
Hydrocotyle	Saltpond Pennywort	State Threatened
Hypericum adpressum	Creeping St. John's-wort	State Threatened
Hypericum hypericodes ssp. Multicaule	St. Andrew's Cross	State Endangered
Lechea pulchella var. moniliformis	Bead Pinweed	State Endangered
Leptochloa fusca ssp. Fascicularis	Saltpond Grass	State Threatened
Liatris scariosa var. novae-angliae	New England Blazing Star	State Special Concern
Linum intercursum	Sandplain Flax	State Special Concern
Lobelia siphilitica	Great Blue Lobelia	State Endangered
Lycopodiella alopecuroides	Foxtail Clubmoss	State Endangered
Lycopus rubellus	Gypsywort	State Endangered
Malaxis bayardi	Bayard's Green Adder's-mouth	State Endangered
Mertensi Maritime	Oysterleaf	State Endangered
Nabalus sepentarius	Lion's Foot	State Endangered
Ophioglossum pusillum	Adder's-tounge Fern	State Threatened
Optunia humifusa	Prickly Pear	State Endangered
Persicaria setacea	Strigose Knotweed	State Threatened
Polygonum glaucum	Sea-beach Knotweed	State Special Concern
Rhynchospora torreyana	Torrey's Beak-sedge	State Endangered
Rumex pallidus	Seabeach Dock	State Threatened
Rumex verticillatus	Swamp Dock	State Threatened

Table 1-4 Federal- and State-Listed Endangered and Threatened Animal and Plant Species Found on in the Vicinity of the MRS (Concluded)

Scientific Name	Common Name	State Protection Status
Plants (concluded)		
Sabatia campanulata	Slender Marsh Pink	State Endangered
Sabatia kennedyana	Plymouth Gentian	State Special Concern
Sanicula Canadensis	Canadian Sanicle	State Threatened
Scleria pauciflora	Papilose Nut-sedge	State Endangered
Scleria triglomerata	Tall Nut-sedge	State Endangered
Setaria parviflora	Bistly Foxtail	State Special Concern
Sisyrinchium fuscatum	Sandplain Blue-eyed Grass	State Special Concern
Spenopholis pensylvanica	Swamp Oats	State Threatened
Suaeda calceoliformis	American Site-blite	State Special Concern
Symphyrotrichum concolor	Eastern Silvery Aster	State Endangered
Tillea aquatic	Pygmyweed	State Threatened
Triosteum perfoliatum	Broad Tinker's-weed	State Endangered
Tripsacum dactyloides	Northern Gama-grass	State Endangered
Utricularia subulata	Subulate Bladderwort	State Special Concern

Notes: NESHP, 2010

During the RI, the on-site environmental monitor did observe Northern Harriers, but no negative impacts were noted and no investigation plan deviations were incurred as a result of sightings within the MRS boundary. No Piping Plover nests were observed along the beach, and the local conservation and resource agency, the NCF, indicated that the beach habitat within the MRS is currently not a suitable habitat for nesting shorebirds due to the significant erosion that has occurred and no nests have been observed there for several years. Consistent with this assumption, terns were also observed on the beach on several occasions, but no nests were observed and no negative impacts were noted. No American Burying Beetles were observed during intrusive activities. This observation was consistent with on-site consultation provided by an expert with the Maria Mitchell Association (a local natural resource and education organization), who indicated that known populations of the beetle are located north of the MRS.

A vast percentage of land within the MRS boundary is inaccessible due to thick vegetation. The NCF provided their inventory of natural community types to aid in the determination of the types of natural communities within the project area. **Table 1-5** summarizes the terrestrial natural communities present within the MRS and their percent coverage of the terrestrial portion of the MRS (NCF, 1999). **Figure 1-12** depicts the distribution of the terrestrial natural communities present within the MRS boundary.

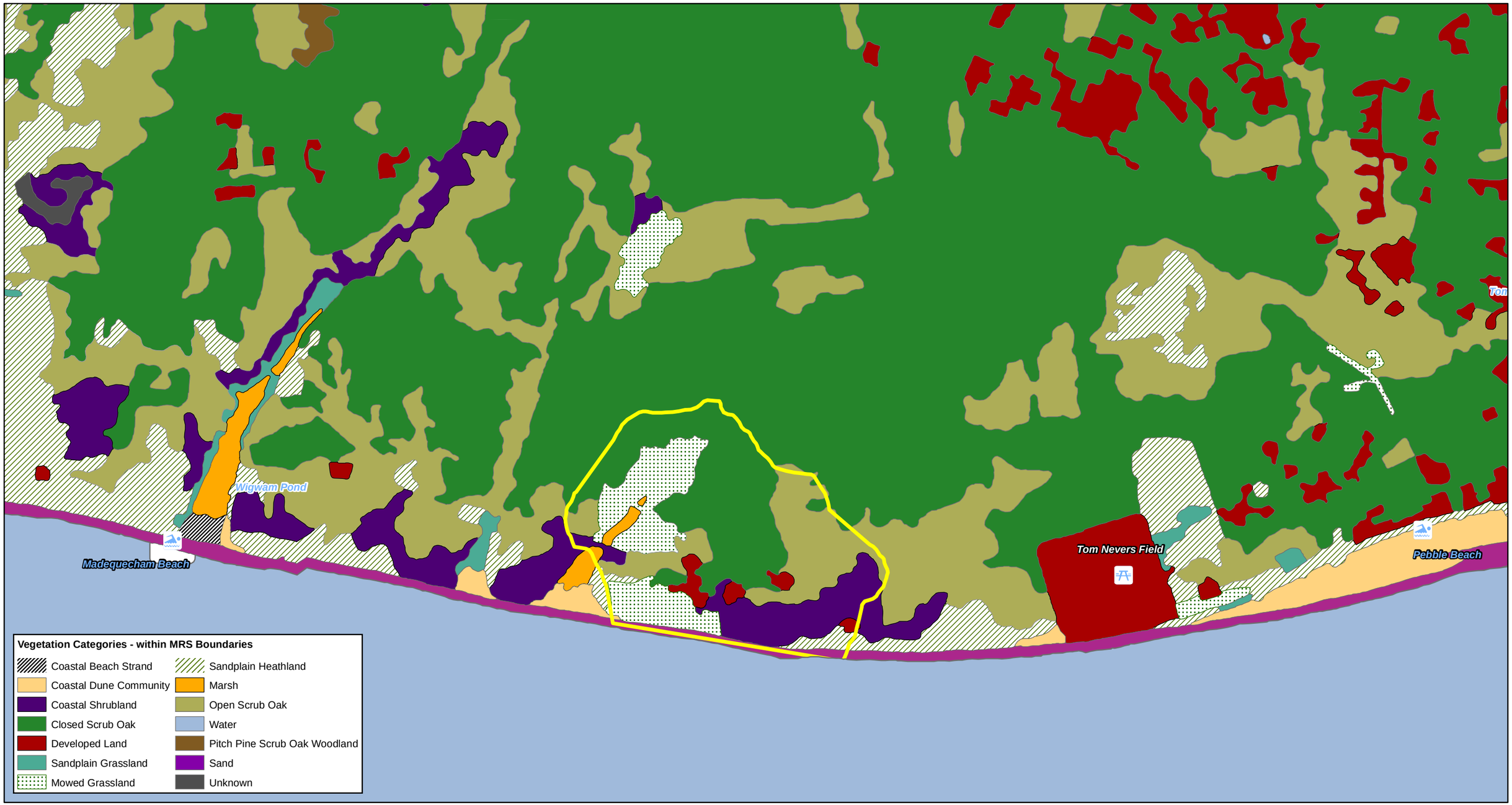
Table 1-5 Terrestrial Habitat Types within the MRS

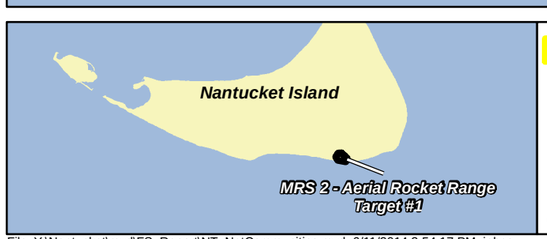
Habitat Type	Habitat	Coverage
Coastal	Sand	7%
Sandplain	Mowed Grassland	22%
	Sandplain Heathland	2%
	Open Scrub Oak Woodland	21%
	Closed Scrub Oak Woodland	35%
Other Shrub & Forest	Coastal Shrubland	9%
Other Wetland	Marsh	1%
Other	Developed Land	4%

Notes: (NCF, 1999)

1.3.2.6.1 Priority Natural Communities and BioMap2 Resources

The NHESP tracks the locations of federal- and state-listed species in two datasets available through the MassGIS: NHESP Priority Habitats of Rare Species and NHESP Estimated Habitats of Rare Wildlife. Both of these habitat types occur in the MRS. **Figure 1-13** depicts the extents of NHESP Estimated Habitats of Rare Wildlife and Priority Habitats of Rare Species (MassGIS, 2011). The NHESP Priority Habitats of Rare Species is the geographical extent of habitat for all state-listed rare species (threatened, endangered and species of special concern designated by the Massachusetts Division of Fisheries and Wildlife), both plants and animals, and is codified under the Massachusetts Endangered Species Act.





Aerial Rocket Range
Target #1 MRS Boundary

Source:
Nantucket Conservation Foundation, Inc., 1999.
Nantucket Vegetation Community Types, with accompanying shapefiles. Undated.

Coordinate System:
UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 540 1,080 1,620 Feet

0 200 400 600 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004)

FIGURE 1-12
Natural Communities

6/11/2014	NT_NatCommunities
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FUDS Boundary
Aerial Rocket Range Target #1 MRS Boundary
NHESP Priority Habitats of Rare Species
NHESP Estimated Habitats of Rare Wildlife

Coordinate System:
UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 670 1,340 2,010 Feet

0 250 500 750 Meters

NOTES:
Aerial Data Source: ESRI iCubed Imagery Prime World 2D (2004)
Base Data: USACE (2004); MassGIS (2011)

FIGURE 1-13
Estimated Habitats of Rare Wildlife and Priority Habitats of Rare Species

6/11/2014	NT_Rare_Spec_WL
Drawn: johna	PROJ: 03886.551.004

BioMap2, developed in a partnership between NHESP and The Nature Conservancy, is designed to guide strategic biodiversity conservation in the Commonwealth over the next decade by focusing land protection and stewardship on the areas that are most critical for ensuring the long-term persistence of rare and other native species and their habitats, exemplary natural communities, and a diversity of ecosystems. BioMap2 is also designed to include the habitats and species of conservation concern identified in the State Wildlife Action Plan. **Figure 1-14** depicts NHESP BioMap 2 Critical Natural Landscape Blocks, Critical Natural Landscape Tern Foraging Areas, and Core Habitat for Species of Conservation Concern, as provided by the MassGIS (MassGIS, 2011).

1.3.2.6.2 Coastal Zone Resources

The Commonwealth of Massachusetts Office of Coastal Zone Management (OCZM) administers the Massachusetts Coastal Zone Management Program in partnership with local governments and state and federal agencies. All of Nantucket County is included in the state's coastal zone (OCZM, 2011).

Several species of whales and sea turtles listed under the Endangered Species Act can occur seasonally in waters off the coast of Nantucket, in the off-shore marine habitats of the project area (NMFS, 2011). Gray and harbor seals are the most common seals found in the waters of Nantucket and Martha's Vineyard while surf clam habitat exists in the nearshore locations of the project area (Massachusetts Division of Marine Fisheries, 2012). Numerous seal sightings were observed during underwater operations, but no negative impacts were noted (WESTON, 2013).

1.3.2.7 Cultural and Archaeological Resources

Nantucket Island is listed on the National Register of Historic Places and is also designated a National Historic Landmark. The Massachusetts Historical Commission indicates that the entire Island of Nantucket is listed as a historic district in the National Register of Historic Places and is designated as a National Historic Landmark. The Island of Nantucket is archaeologically-sensitive and likely contains areas of cultural significance to the Wampanoag Tribe. No cultural or archaeologically significant findings have been reported to date from inspections and the RI conducted within the MRS boundary.

Aerial Rocket Range Target #1 MRS Boundary

FUDS Boundary

Critical Natural Landscape Tern Foraging Areas

Critical Natural Landscape Landscape Blocks

Core Habitat for Species of Conservation Concern

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

WESTON SOLUTIONS

FIGURE 1-14
Critical Natural Landscape, Tern Foraging Areas and Species of Conservation Concern

N

0 670 1,340 2,010 Feet

0 250 500 750 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004); MassGIS (2011)

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1.3.2.8 Demographics

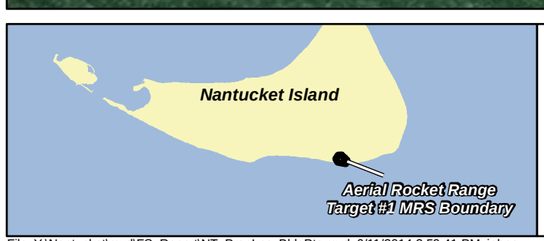
Nantucket is a popular tourist destination, known for its abundance, and preservation of rare ecosystems in addition to historical places. The population of Nantucket is around 10,000 year-round residents in the off-season and over 50,000 seasonal residents and tourists in the summer months. Nantucket Island has experienced a 6.8% population increase since 2000. The average number of households is 3,493 with an average occupation size of 2.9 people per household and a median annual income of $68,746 (2009). Approximately 92% of the population has a high school or higher educational degree. The median age is 39.4 years and the racial demographics include primarily Caucasians (88%), with African Americans, American Indians, Asians, and others comprising the remainder (12%) of the population (U.S. Census Bureau, 2010). Tourism is the major industry of Nantucket County.

Although the portion of Nantucket Island where the MRS is located is not a highly visited area due mainly to private ownership and seasonal tourism, numerous parcels of land located within the MRS and in nearby proximity to its boundary are open for recreational use. Private residences include year-round homes in addition to seasonal vacation homes.

1.3.2.9 Current and Projected Land Use

The 97-acre Aerial Rocket Range Target #1 MRS boundary where MD has been confirmed to be present includes portions of parcels owned by private residents or the NCF (see **Figure 1-15**) that is undeveloped, or used for residential or recreational purposes. Residential activities including construction and/or property maintenance may include surface and subsurface soil disturbance.

On non-residential portions of the MRS, recreational use of the beach and along established paths in the uplands portion of the MRS is allowed. Recreational activities typically involve foot and vehicle traffic, with limited intrusive activities (e.g., children digging in the sand). The MRS provides habitat for a variety of plants and animals.



Building
T-1 Former Target
FUDS Boundary
Aerial Rocket Range Target #1 MRS Boundary
Nantucket Conservation Foundation
Nantucket Island Land Bank
Nantucket Housing Authority
Private Residence
Town of Nantucket

Coordinate System: UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 380 760 1,140 Feet

0 140 280 420 Meters

NOTES:
Aerial Data Source: ESRI, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and swisstopo.
Base Data: USACE (2004)
County of Nantucket (2011)

FIGURE 1-15
Property Lines and Buildings
Nantucket, MA

6/11/2014	NT_PropLns_BldgPts
Drawn: johna	PROJ: 03886.551.004

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There is no anticipated change in land use. The land within the MRS boundary consists of maintained landscaping, upland scrub vegetation, beach grass dunes/bluffs, and includes the beach below the bluffs where MD has been identified due to extensive and on-going coastal erosion that periodically causes subsurface MD to fall out onto the beach. Based on the property line for the FUDS recorded on a survey map from 1943 (USACE, 1997), the beach has eroded approximately 800 ft between the time of active use and present day.

1.3.3 Remedial Investigation Conclusions

The following conclusions were drawn from RI findings:

- No features indicative of a burial pit were detected.
- Air-to-ground rocket training activities were conducted at one location known as anomaly cluster AC-01/Target #1.
- No UXO or DMM was identified during the SI or RI, and all recovered MD was discovered within AC-01/Target #1.
- The nature and extent of MD has been adequately defined and is located on ground surface and subsurface within the AC-01/Target #1 area encompassing 97 acres.
- The maximum depth of MD recovered during the RI within the highest density of observed MD in the AC-01/Target #1 area was 8 ft bgs.
- An explosive safety hazard is not anticipated to exist at AC-01/Target #1.
- No COPCs, COPECs or significant risks from MC in soil or groundwater to potential human or ecological receptors were identified.
- All MEC and MC pathways to potential receptors have been determined to be incomplete for lack of a confirmed source [the updated CSM pathway diagrams for MEC and MC with supporting text excerpted from the *Final RI Report* (WESTON, 2013) is provided as **Appendix A**].

Since all DQOs were met, the results of the RI concluded that characterization was complete. Based on the lack of a MEC discovered during the SI or RI to provide data on a hazard source, USACE determined that a MEC HA was not warranted. The boundary for the MRS was established to encompass the 97-acre impact area delineated in the vicinity of former Target #1 where MD was identified and characterized (see **Figure 1-4**). While no UXO or DMM was

found during the investigation, the significant amount of MD estimated to remain indicates that property owners and users will likely continue to encounter intact munitions in the future. Although it is most likely that munitions recovered in the future will be inert, this determination should only be made by trained authorities. Therefore, an FS was recommended to address the 97 acres delineated as the Aerial Rocket Range Target #1 MRS. (WESTON, 2013)

No action was recommended for the remaining 5,059.9 acres delineated as the Aerial Rocket Range Fan MRS as no UXO or MD have been confirmed within this area based on data and information collected to date for the FUDS.

SECTION 2

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND TO BE CONSIDERED CRITERIA

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

Pursuant to 40 Code of Federal Regulations (CFR) Part 300.400(g) of the NCP, a list of ARARs and other TBC information is developed for a site or sites to identify the requirements that may apply to a removal or remedial action. 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. Lead and support agencies may, as appropriate, identify other advisories, criteria, or guidance TBC.

ARARs are defined as follows:

- Applicable requirements - Those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state environmental law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.
- Relevant and appropriate requirements - Those cleanup standards, standards of control, and other substantive environmental protection requirements promulgated under federal or state environmental law that, while not applicable to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site.

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.

It is first determined whether an ARAR is applicable for the site. If it is not applicable, then it is determined whether the ARAR is relevant and appropriate. The procedure for determining whether a requirement is relevant and appropriate is a two-step process. First, to determine

relevance, it is evaluated whether the requirement addresses problems or situations sufficiently similar to the circumstances of the proposed response action. Second, for appropriateness, the determination must be made about whether the requirement would also be well-suited to the conditions of the site. In some cases, only a portion of a requirement would be both relevant and appropriate. Once a requirement is deemed relevant and appropriate, it must be attained (or waived). If a requirement is not both relevant and appropriate, it is not an ARAR.

"Applicable requirements" and "relevant and appropriate requirements" are considered to have the same weight under CERCLA. Section 121(d) of CERCLA, as amended by SARA, requires attainment of federal ARARs and of state ARARs in state environmental or facility siting laws where the state requirements are promulgated, more stringent than federal laws, and identified by the state in a timely manner.

CERCLA and the NCP also recognize the TBC category, which includes non-promulgated federal and state criteria, strategies, advisories, and guidance documents. The TBC information do not have the same status as ARARs; but, if no ARAR exists for a substance or particular situation, TBCs may be used to ensure that a remedy is protective.

The ARARs identified for the Aerial Rocket Range Target #1 MRS for the FS based on the results of the RI, and following notification to the State are summarized on **Table 2-1**. Written notification was provided to the Massachusetts Department of Environmental Protection (MassDEP) in a letter from USACE dated 15 November 2013 of the identified federal ARARs, with a formal request that any more stringent State ARARs be identified to support the FS.

Table 2-1 Preliminary Identification of Potential Applicable or Relevant and Appropriate Requirements, and To be Considered Information

Standard, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comment
Action-Specific			
Resource Conservation and Recovery Act, Miscellaneous Units	40 CFR 264.601/602/603	Establishes requirements under RCRA 40 CFR 264 subpart X applicable to operators of open burning/open detonation of explosive waste, including military munitions/explosive wastes. Specifically, 40 CFR 264.601, 264.602, and 264.603 require that miscellaneous units be located, designed, constructed, operated, maintained, monitored and closed in a manner that will ensure protection of human health and the environment. Only substantive portions are appropriate.	Appropriate For any future remedial alternatives that address MEC disposal using technologies or disposal means classified as "miscellaneous units" under Subpart X, including consolidated detonation areas
Location-Specific			
Federal Endangered Species Regulations	16 U.S.C. §1538(a)(1)	With respect to any endangered species of fish or wildlife listed pursuant to Section 1533 of Title 16 (Conservation), it is unlawful for any person subject to the jurisdiction of the U.S. to take any such species within the U.S. or the territorial sea of the U.S.	Appropriate For any future response actions that may impact listed species

Notes:

RCRA – Resource Conservation and Recovery Act
CFR – Code of Federal Regulation
U.S.C – United Stated Code

SECTION 3

IDENTIFICATION AND SCREENING OF TECHNOLOGIES

3. IDENTIFICATION AND SCREENING OF TECHNOLOGIES

This section establishes the RAO for the FS and identifies general response actions and potential detection and removal technologies to address munitions remaining at the Aerial Rocket Range Target #1 MRS. An initial screening is performed for effectiveness, implementability, and cost to evaluate viability for use at the MRS. The general response actions and viable technologies identified in this section are assembled into process options that can achieve the RAO in the Development and Screening of Alternatives (Section 4) and are further evaluated in the Detailed Analysis of Alternatives (Section 5) of this report.

3.1 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. The 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 Environmental Command (USAEC), 2009]. The RAO for the Aerial Rocket Range Target #1 MRS addresses the overall goal of managing risk and protecting human health based on the results of the RI.

No UXO was found during the RI field work and the revised MEC CSM identifies incomplete pathways for all receptors with access to the Aerial Rocket Range Target #1 MRS based on current and future anticipated land use. The MD (intact aerial rockets and associated components) was however confirmed within the Aerial Rocket Range Target #1 MRS at ground surface and in subsurface soil to depths up to 8 ft. Based on the penetration depth for the type of aerial rockets discovered and MRS soil characteristics, the maximum depth for remaining munitions is estimated to be 12.5 ft bgs.

Due to the significant volume of munitions estimated to remain at ground surface and within subsurface soil at the Aerial Rocket Range Target #1 MRS, residents, NCF personnel, contractors/maintenance workers, visitors/trespassers, and recreational users, on residential and/or NCF property may encounter munitions while engaging in surface and intrusive activities.

Although the aerial rockets and associated components were characterized as inert during the RI field work, this determination should only be made by trained authorities. Therefore, the RAO for the Aerial Rocket Range Target #1 MRS is:

- To reduce the probability of residents, NCF personnel, contractor/maintenance workers, visitors/trespassers, and recreational users from handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil.

3.2 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 Aerial Rocket Range Target #1 MRS:

- **Risk Management -** Risk Management, which is considered a "limited" action alternative by EPA, includes various land use control(s) (LUC) options that rely on legal mechanisms, engineering controls, or administrative functions to control access or modify human behavior and provide long-term management (LTM) of risk.
- **Removal Action –** Remaining munitions can be detected and removed from the ground surface and/or below the ground surface. Alternatives for munitions clearance include technologies for detection, positioning for the detection technologies, removal, and disposal.

3.3 EVALUATION OF TECHNOLOGIES

Various technologies and approaches exist to manage risks associated with munitions. Risk management can be accomplished through a variety of engineering and/or institutional control (IC) components (i.e., LUCs) designed for implementation based on a MRS-specific conditions. Clearance 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 for use at the Aerial Rocket Range Target #1 MRS.

3.3.1 Screening Criteria

Potential remedial technologies are first evaluated against the three general categories of effectiveness, implementability, and cost described below. The purpose of this initial screening is to ensure that the technologies meet the minimum standards of the criteria within each category in the FS process and can be used to assemble viable remedial alternatives to achieve the RAO. The three general categories are described in the following sections.

3.3.1.1 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 RAO; (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.

3.3.1.2 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).

3.3.1.3 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 (EPA, 1988).

In the detailed analysis in Section 5, which presents an evaluation of the costs of remedial action alternatives, both capital and LTM costs are considered, where appropriate. The evaluation includes the LTM 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 value 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.

3.3.2 Land Use Controls

In accordance with DERP FUDS program guidance, the term LUCs encompasses physical, legal, or administrative mechanisms that restrict the use of, or limit access to, contaminated property to reduce risk to human health and the environment. Physical mechanisms encompass a variety of

engineered remedies to contain or reduce contamination and physical barriers to limit access to property (e.g., fences). The legal mechanisms are generally the same as those used for ICs as discussed in the NCP. Institutional controls are a subset of LUCs and are primarily legal mechanisms imposed to ensure the continued effectiveness of land use restrictions imposed as part of a remedial decision. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms include notices, adopted local land use plans and ordinances, educational programs, construction permitting, or other existing land use management systems that may be used to ensure compliance with use restrictions (USACE, 2004). Educational programs can include a variety of types of information dissemination and training that can be tailored to specifically address an identified hazard and exposed populations.

Development of LUC components considered for the Aerial Rocket Range Target #1 MRS referred to the USACE guidance EP 1110-1-24 for Establishing and Maintaining Institutional Controls for Ordnance and Explosive (OE) Projects (USACE, 2000). The main objective is to design controls that rely on legal mechanisms, physical barriers/warning, or administrative mechanisms, such as educational components to restrict access and/or modify human behavior to reduce exposure risks. LUCs should be managed and maintained at the local level whenever possible. For FUDS properties, property owners or state/local government agencies with appropriate authorities (i.e., zoning boards) are often the best candidates for LUC management and enforcement (USACE, 2004).

Effectiveness of LUCs is dependent on coordination and willingness to participate in maintenance/enforcement by all stakeholders for the duration that the specific control applies to the MRS. When LUCs are established, the ability to perform periodic inspections and measure effectiveness is critical to attaining remedial objectives. Land use controls to guide human behavior and manage risk are described and screened against the three criteria of effectiveness, implementability, and cost for use at the Aerial Rocket Range Target #1 MRS in **Table 3-1.**

Table 3-1 Land Use Controls

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
Legal Mechanisms: Institutional controls such as deed restrictions	**High**: When imposed and enforced, legal restrictions can effectively limit or prevent exposure risks to a known hazard and can be evaluated for effectiveness via periodic inspection.	**Very Difficult**: Because any legal mechanisms would need to be established by the property owners (non-DoD entities); to implement this type of control the Army can only assist in a coordination capacity with the landowner to guide implementation in an effective manner.	**Low – Moderate**: Costs are variable based on level of effort.	Administrative	MRS is a non-DoD property managed under FUDS without the ability for the Army to impose legal restrictions. Any legal mechanisms would need to be established by the property owners.	**Low/Not Retained:** Because the MRS is a FUDS, the Army cannot impose legal restrictions on the privately-owned parcels included within the MRS boundary. The Army can coordinate with the current property owners to design legal mechanisms to required documents in an effective manner.

Table 3-1 Land Use Controls (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
Engineering Controls: Commonly includes physical barriers to prevent access such as fencing, signage or guard posts. Stabilization/protection measures for the coastal bluff also considered due to the unique physical characteristics of the MRS. Because construction of hard structures on beaches and dunes is prohibited under state law (Massachusetts Wetland Protection Act), actions would be limited to construction of artificial dunes or dune nourishment (i.e., addition of like sediments/materials to existing beach or dune area).	**Low - Moderate**: Fencing, signage or guards to restrict access is not anticipated to be very effective at this MRS as the extent of munitions encompasses several residential parcels (partially or in their entirety) and portions of privately-owned parcels used for conservation purposes. Stabilizing the bluff would effectively reduce the probability of subsurface munitions becoming accessible at ground surface along the beach, but will require routine maintenance over the long-term to ensure effectiveness, and does not address the subsurface pathway for exposure for property owners engaging in intrusive activities where the bulk of munitions are currently located.	**Very Difficult**: Although fencing/signage/guards are relatively easy to implement as physical barriers, installation on the privately-owned properties is impractical given current use. For bluff stabilization, activities would involve significant pre-construction design; evaluation of potential adverse environmental impacts and mitigation measures; heavy construction equipment use; may warrant extending the work area significantly beyond the boundary of the FUDS to adequately protect against coastal erosion. During construction efforts, interim measures would need to be taken to maintain the integrity of the coastline temporarily.	**Low – High**: Lower costs associated with physical barriers, but extremely high costs are anticipated with bluff stabilization measures that would need to be taken.	Fencing/guards Heavy and light construction equipment and construction materials (e.g., sand, gravel, cobbles, etc.).	Long-term effectiveness is expected to require periodic inspection and, in the case of bluff stabilization routine repair based on the high energy coastline dynamics present within the MRS.	**Low/Not Retained**: Due to private land ownership and current/anticipated future use within the MRS, fencing, signs and guards are impractical for use to control access. For bluff stabilization, the difficulty in implementation, and significant capital, operations and maintenance costs preclude identifying this a viable engineering control for the MRS.

Table 3-1 Land Use Controls (concluded)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
Administrative Mechanisms: Educational programs including public information dissemination and/or advisories (e.g., signs, written protocol/guidance, brochures, fact sheets, training programs, etc.); management through permitting requirements	**Moderate - High**: Educational components work very well when tailored to the specific populations at risk of exposure through behavior modification. Multiple formats are available for use to convey information to target groups, and periodic inspections can be used to verify effectiveness in the future at the Aerial Rocket Range Target #1 MRS. Under the state Excavation & Trench Safety Regulation, permitting is required for excavation greater than 3 ft deep, and less than 15 ft wide through local municipalities, which may be effective for managing ground-breaking activities that meet this requirement within the MRS.	**Easy**: Easily implementable for MRSs where the nature and extent of hazards are known, and baseline risks have been established for all complete source/interaction/receptors pathways that are present. Execution is limited to primarily administrative functions with limited field work to erect signage, conduct training sessions and/or information meetings for the public. Based on data collected through the RI for this MRS, the nature and extent of munitions-related hazards has been fully characterized. Permitting execution is limited to administrative functions and is dependent on the local municipality's willingness to modify process for properties (8 parcels) within the MRS boundary.	**Low**: Costs are variable based on level of effort.	Administrative to produce informational materials, provide in-person/video training, or manage permit approval.	Signs displaying 3Rs and site information are already being installed at public access points based on a USACE site visit (HFA, 2011) as an interim measure.	**High/Retained:** All landowners, local officials and regulatory agencies are aware of the MRS history, have been part of (or invited to participate) meetings regarding the results of MRS investigations and decision making, and are anticipated to continue to be receptive to informational materials provided in the future.

To facilitate development and evaluation of LUC options and viability for use at the Aerial Rocket Range Target #1 MRS, an Institutional Analysis was performed for the MRS to support the FS and is provided as **Appendix B**.

3.3.2.1 Coastal Bluff Stabilization

Based on the physical characteristics of this MRS, the dynamic nature of the coastal environment is a significant factor affecting migration of and access to the munitions present at the Aerial Rocket Target #1 MRS. Subsurface munitions may become readily accessible at ground surface due to the aggressive erosion of the coastal bluffs that are receding and encroaching the impact area delineated in the vicinity of former Target #1. The FUDS property boundary (shown on **Figure 1-2**) was established along the coastline at the time the property was leased, and based on the location of the current coastline, approximately 800 ft has eroded during the last 70 years. Therefore, stabilization of the bluff is considered as an engineering control in the screening of technologies for the MRS.

3.3.3 Munitions Debris Detection

Detection technologies include those methods and instruments used to locate surface and subsurface munitions for clearance, which are the same as those used for MEC as the properties of the munitions are the same that would be detected. The best detection method is selected based on the munitions properties such as the depth and size of the suspected items, and the physical characteristics of the site (i.e., soil type, topography, vegetation, and local geology).

There are two basic forms of munitions detection. The first, visual searching, has been successfully used at a number of sites where munitions are 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 munitions. A metal detector is sometimes used to supplement the visual search in areas where ground vegetation may conceal surface munitions. Typically, any munitions found during these searches is flagged or marked for immediate disposal.

The second form of detection, geophysics, includes various detection instruments designed to locate subsurface munitions 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 munitions include magnetometers and electromagnetic instruments. Positioning technologies include various equipment and instruments that establish geo-referenced positions for subsurface anomalies detected using munitions detection technologies. The viability of positioning technologies is affected by site conditions, including terrain, tree canopy, and vegetation density.

The munitions detection technologies and positioning technologies are described and screened against the three criteria of effectiveness, implementability, and cost for use at the Aerial Rocket Range Target #1 MRS in **Table 3-2** and **Table 3-3**, respectively. Site-specific performance results for equipment tested and employed during the RI at this MRS is incorporated into the technology screening to the extent possible.

Table 3-2 Detection Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
Visual Searching	**Low - Moderate**: Effective for surface clearance in open areas with little ground cover. Not appropriate for subsurface clearance.	**Easy**: Easily implemented by qualified UXO Technicians and sweep personnel. Minimal to no impacts to cultural or natural resources.	**Low**: Lower than other methods that requires detection instrumentation and associated equipment.	NA	Typically supported with a flux-gate magnetometer or frequency-domain electromagnetic induction (FDEMI) metal detector.	**Low – Moderate/Retained**: The bulk of munitions on residential properties are located in the subsurface, although surface MD was detected. Where surface munitions exists on established recreational paths and the beach below the bluffs accessible to recreational users and private land owners, visual detection of munitions would be effective since the risk for exposure is at ground surface.
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.	**Moderate - High**: Flux-gate magnetometers have been used as the primary detector in traditional mag & dig operations. There is a high industry familiarization. Detects ferrous objects only.	**Easy**: 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.	**Moderate – High/Retained**: Magnetometers were used effectively during the RI at the MRS; the nature of munitions characterized indicated practice aerial rockets with high ferrous content are present.

Table 3-2 Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Low**: 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.	**Moderate**: 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.	**Moderate**: 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/Not Retained**: Proton precession systems are not viable options as a standalone detection system at the Aerial Rocket Range Target #1 MRS because of low implementability.

Table 3-2 Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Moderate to Difficult**: Equipment is digital, rugged, 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, which are present in the MRS based on RI findings and known geology. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Moderate – 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.	**Moderate/Retained**: Magnetometers were used effectively during the RI at the MRS; the nature of munitions characterized indicated practice aerial rockets with high ferrous content are present; costs associated with addressing a 97-acre MRS are assumed to be high.

Table 3-2 Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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 EM61-MK2 was tested and proven effective for digital geophysical mapping (DGM) during the Aerial Rocket Range Target #1 MRS RI.	**Easy - Moderate**: 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.	**Moderate – 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-MK2A 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.	**Moderate/Retained**: This technology was proven effective in open and accessible areas at the Aerial Rocket Range Target #1 MRS during the RI. Because of the dense vegetation at the MRS, only a small accessible area of the MRS remains that could be investigated using this technology.

Table 3-2 Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Moderate – 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.	**Moderate**: 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) TEMTAD TEMTADS 2x2	Sensors have limited industry availability. Requires advanced training for operation, data processing, and analysis.	**Low – Moderate/Not Retained**: 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 dense vegetation and sensitive coastal bluff located within the MRS. Only the MetalMapper is currently commercially available. All other systems are under development or in testing.

Table 3-2 Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
Frequency-Domain Electromagnetic Induction (FDEMI) Metal Detectors: FDEMI sensors generate one or more defined frequencies in a continuous mode of operation.	**Moderate - 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 White's All-Metals Detector was proven effective during the RI at the MRS.	**Easy**: 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.	**Moderate**: 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.	**Moderate – High/Retained**: This technology was proven effective at the MRS during the RI. FDEMI detects all metals, instead of only ferrous items.

Table 3-2 Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Low**: Detects both ferrous and non-ferrous metallic objects. Capable tool for detection of deep MEC. Low industry familiarization. System has seen limited application.	**Difficult**: 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/Not Retained**: 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.	**Moderate - Difficult**: 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/Not Retained**: Difficult to implement, high cost, only available from a few sources. Towed array is not implementable at the MRS because of the dense vegetation that reduce the accessibility of the system.

Table 3-2 Detection Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Difficult**: 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.	Intermap Technologies Corp., (STAR systems)	Few have applied these technologies to detect MEC.	**Low/Not Retained**: Difficult to implement, high cost, only available from a few sources. Residential homes within MRS boundary restrict available area remaining for airborne survey. Only surface features of interest are detected using this technology because it requires line of sight.

Table 3-2 Detection Technologies (concluded)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
Airborne Laser and Infrared (IR) Sensors: IR and laser technologies can be used to identify objects by measuring their thermal energy signatures, or distance through light detection and ranging (laser pulse). 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.	**Difficult**: 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.	Riegl LMS-Q560, Leica ALS 50-II / ALS 60/ALS 70 FLIR Systems StarSAFIRE 230-HD	Few have applied these technologies to detect MEC.	**Low/Not Retained**: Difficult to implement, high cost, only available from a few sources. Residential homes within MRS boundary restrict available area remaining for airborne survey.

Table 3-3 Positioning Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**High**: 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.	**Easy - Moderate**: Easy to operate and set up. Requires trained operators. Available from a number of vendors. Better systems are typically rugged 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.	**High**: 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.	**High/Retained**: This technology is not effective in wooded areas with tree canopy, however, vegetation within the MRS on non-landscaped portions is dense but scrub-like. No tree canopy exists to limit implementability.

Table 3-3 Positioning Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Moderate - 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.	**Easy - Moderate**: 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.	**High**: 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).	**Moderate – High/Retained**: 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.

Table 3-3 Positioning Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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).	**Moderate - High**: Moderate to high effectiveness when performed by experienced personnel. Low effectiveness when used by inexperienced personnel. Commonly achieved accuracy is 15 to 30 centimeters.	**Moderate**: 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 - Moderate**: 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.	**Low/Not Retained**: Because of the dense vegetation at the MRS, only a small accessible area remains where the fiducial method could be used.

Table 3-3 Positioning Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
Odometer Method: This method utilizes an odometer that physically measures the distance traveled.	**Moderate**: Moderate 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.	**Moderate - Difficult**: 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/Not Retained**: Based on the estimated quantity of munitions remaining, this method is impractical for use given the anticipated need for accurate anomaly resolution during a future response action.
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 – Moderate**: 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.	**Difficult**: 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 ft. 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.	Ultrasonic Ranging and Data System (USRADS)	Requires trained operators. Has been used extensively in wooded areas with success.	**Low/Not Retained**: Technology could be used in densely vegetated portions of the MRS. High costs limit its viability.

Table 3-3 Positioning Technologies (concluded)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at the Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Difficult**: 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/Not Retained**: This technology has a low viability at the MRS because of limited range of use and high costs.

3.3.4 Munitions Debris Clearance

Clearance operations for munitions can take the form of a surface-only clearance, an intrusive (subsurface) clearance, 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 clearance operation, exposed munitions are identified during the detection phase. The munitions 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 munitions identified by a geophysical survey or other detection methods require excavation for clearance. 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 Aerial Rocket Range Target #1 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 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.

Removal technologies applicable to clearance of munitions at the Aerial Rocket Range Target #1 MRS are described in **Table 3-4** and are screened against the three criteria of effectiveness, implementability, and cost.

Table 3-4 Removal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
Hand Excavation: Technique includes digging individual anomalies using commonly available hand tools.	**Moderate - High**: This is the industry standard for munitions removal. It can be very thorough and provides an excellent means of data collection. For surface removals, this method would be highly effective. For subsurface removals, as depth and extent of removal increases the labor and time duration required for hand excavation also increases.	**Easy - Moderate**: 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.	**Moderate – High/Retained**: This technology was successfully used during the Aerial Rocket Range Target#1 MRS RI. Because of the development, sensitive coastal bluffs, and vegetation at the MRS, only a small accessible area of the MRS remains where a removal action could be easily performed.

Table 3-4 Removal Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
Mechanical Excavation of Individual Anomalies: This method uses commonly available mechanical excavating equipment to support hand excavations.	**Moderate - High**: Used in conjunction with hand excavation when soil is too hard, excavation depths are deep and/or addressing areas with higher densities of munitions causing time delays, or safety concerns during hand excavation. Method works well for the excavation of deep single anomalies to remove overburden.	**Easy - Moderate**: 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. Restoration required for disturbed areas. Moderate impacts to natural resources because roadways would be constructed and large-scale intrusion would take place to allow equipment into areas.	**Low to High**: In hard soil and concentrated areas of munitions at depths greater than 12 inches, 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.	**Moderate – High/Retained**: For deep subsurface anomalies not easily accessible by hand excavation. Because of the development, sensitive coastal bluffs, and vegetation at the MRS, only a small accessible area of the MRS remains where a removal action could be easily performed. Will require vegetation clearing for equipment access only.

Table 3-4 Removal Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
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 munitions from soil.	**Moderate**: 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 munitions.	**Difficult**: 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 heavily wooded areas with numerous ecosystems that must be protected. Restoration required for disturbed areas. Major impacts to cultural and natural resources because roadways, stockpiles, and material laydown areas would need to be established.	**High**: Mass earth moving equipment is expensive to rent and insure and has the added expense of high maintenance and restoration costs.	**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 to Moderate/ Retained**: Technology would be effective at the Aerial Rocket Range Target #1 MRS because high densities of munitions are anticipated. However, clear cutting at the MRS would be required to clear heavily vegetated areas that would otherwise be inaccessible to the technology and also to establish roadways and material laydown areas. Technology is costly.

Table 3-4 Removal Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
Magnetically Assisted Removal: Magnets are used to separate conductive material from soils.	**Moderate**: 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 munitions and surface debris, but the size of aerial rocket-related MD characterized during the RI would be unlikely to be picked up by manually-operated rollers. Mechanical systems would be required to assist with surface removal operations.	**Difficult**: Magnetic separators are easily obtained from 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 conveyors are limited in availability but can be procured for use on standard readily available sifting equipment noted above.	Installed by sifting equipment owner.	**Moderate/Retained**: Primarily used in conjunction with mass excavation and sifting operations.

Table 3-4 Removal Technologies (concluded)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
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 munitions removal.	**Difficult**: 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. Restoration required for disturbed areas. Major impacts to 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/Not Retained**: This technology has a low viability at the Aerial Rocket Range Target #1 MRS because of low effectiveness and difficult implementation. Remotely operated removal equipment requires the same earth moving equipment used in mass excavation with the same low implementability because of the heavily vegetated terrain and sensitive coastal bluffs.

3.3.5 Munitions Debris Disposal

Disposal/treatment technologies applicable to the anticipated MDAS waste stream are described in **Table 3-5**, and screened against the three criteria of effectiveness, implementability, and cost for the Aerial Rocket Range Target #1 MRS.

3.3.5.1 Material Potentially Presenting an Explosive Hazard Disposal

Munitions response procedures that would be followed during a clearance regardless of the anticipated lack of explosive hazard, will require provisions to handle MPPEH in the unlikely event that it is encountered. For this reason, **Table 3-6** is provided to describe the disposal technologies that would be used to address MPPEH prior to certification as MDAS for final disposition (as described above in Subsection 3.3.5 and evaluated on **Table 3-5)**.

3.4 VIABLE TECHNOLOGIES FOR THE AERIAL ROCKET RANGE TARGET #1 MRS

The technologies listed in **Tables 3-1** to **3-6** that are the most viable options for the Aerial Rocket Range Target #1 MRS are summarized in **Table 3-7** and are included in the process options assembled for remedial alternatives in Section 4. Because of the inert nature of munitions at the MRS that has been characterized to date, private land ownership, and valuable natural resources, there are limited technologies that are viable options for the Aerial Rocket Range Target #1 MRS. Technologies summarized in **Table 3-7** are the most viable options, and the majority have been demonstrated to be effective at the Aerial Rocket Range Target #1 MRS during the RI or at a similar site.

Table 3-5 Munitions Debris Disposal/Treatment Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
Shredders and Crushers: These technologies use large machines to deform metal components. This results in unusable remnants and overall reduced volume of scrap.	**High**: Shredders are mainly used to render inert munitions 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.	**Difficult - Moderate**: Typically stationary facilities. Service life and very high maintenance are expected. Requires additional handling of munitions. Major impacts to property owners and natural resources because roadways and staging areas would need to be established for equipment.	**Moderate - 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. Limited staging areas available for this type of operation, would require extensive coordination between property owners and considerations of public that access the area in and around the MRS.	**Moderate/Retained**: The technology would likely be effective for handling munitions at the Aerial Rocket Range Target #1 MRS based on RI characterization and lack of identified MEC.
Recycling: Required for MD and non-MD.	**High**: Very effective for MD and non-MD.	**Easy**: Easily implemented if there is a local metal recycler, RI activities successfully used an off-island recycling facility. No additional impacts to property owners or natural resources.	**Low – Moderate**: Scrap metal may be accepted without cost.	NA	Staging areas used during the RI are likely available for use in the future through current property owners for material staging prior to off-island transport based on similarity of task and smaller areas required.	**High/Retained**: MD can be sent to a recycler located off-island.

Table 3-6 Material Potentially Presenting an Explosive Hazard Disposal/Treatment Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**High**: 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.	**Difficult**: Significant personnel exposure in implementation. Specialized personnel, 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.	**Low/Not Retained**: The RSP technology is not viable at the Aerial Rocket Range Target #1 MRS during a clearance alternative conducted by the Army 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 MD anticipated at the MRS. Note: RSP would be employed regardless by EOD during future responses initiated through the 911 alert system, consistent with past actions taken at the MRS to discovered munitions.

Table 3-6 Material Potentially Presenting an Explosive Hazard Disposal/Treatment Technologies (continued)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**Moderate to High**: Each MEC item is individually destroyed with subsequent results individually verified using quality assurance/quality control. BIP yields unconfined releases of MC and MD, which can be restricted using engineering controls. There were no MPPEH items discovered during the RI that were not acceptable to move after inspection by qualified technicians.	**Moderate to Easy**: 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/Retained**: Used for MPPEH that are deemed unsafe to move. Technology has been proven effective in similar field conditions.

Table 3-6 Material Potentially Presenting an Explosive Hazard Disposal/Treatment Technologies (concluded)

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at Aerial Rocket Range Target #1 MRS/Status of Retention
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.	**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. This method was effectively used to consolidate MPPEH for venting at a common location on daily schedule.	**Moderate to Easy**: Generally employs the same techniques, tools, and equipment as BIP procedures. Requires larger area (but less impacted locations overall) and more engineering controls. However, the common location for detonation and ability to schedule events enables better control and management of impacts to the public. Most approved engineering controls are not completely effective/applicable for these operations	**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/Retained**: Only used for MPPEH that is deemed safe to move. Requires an increase in explosive weight over what would be used for a single explosive demolition shot. Proven technology at this MRS for addressing MPPEH and allow for disposal as a MDAS waste stream.

Table 3-7 Viable Technologies for the Aerial Rocket Range Target #1 MRS

Land Use Controls	Detection		Removal	Disposal/Treatment
Institution Controls (Educational)	**Geophysical Detection**	**Positioning**		
▪ Signs ▪ Preparation and distribution of informational materials ▪ Training for local community	▪ 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 & dig), including FDEMI metal detectors. Schonstedts were successfully used at the Aerial Rocket Range Target #1 MRS during the RI and is the most viable analog instrument for use.	▪ Robotic Total Station (with DGM). ▪ Global Position Systems (with DGM).	▪ Hand excavation. ▪ Mechanical excavation. ▪ Mass excavation with sifting.	▪ Off-site recycling - munitions recovered during clearance would be sent off-island for recycling following verification as MDAS and certification that the material is free of explosives. ▪ Blown-in-place and consolidated shot treatment technologies retrained for MPPEH discovered during clearance activities similar to procedures employed during the RI.

SECTION 4

DEVELOPMENT AND SCREENING OF ALTERNATIVES

4. DEVELOPMENT AND SCREENING OF ALTERNATIVES

In this section, the technologies and general response actions deemed viable for use at the Aerial Rocket Range Target #1 (see Section 3) are assembled into remedial alternatives and initially screened against the three criteria of effectiveness, implementability, and cost in a similar manner to the technology screening presented in Subsection 3.3. The remedial alternatives described and determined viable during the initial screening are further evaluated against the NCP criteria independently in a detailed analysis and against each other in a comparative analysis presented in Section 5 of this FS Report.

4.1 DEVELOPMENT OF POTENTIAL REMEDIAL ALTERNATIVES

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. For this FS, the remedial alternatives assembled based on the viable technologies and general response actions identified to achieve the RAO include:

- Alternative 1 – No Action.
- Alternative 2 – LUCs.
- Alternative 3 – Surface clearance to address the beach and NCF trails for recreational use and portions of residential properties where ground surface is accessible (approximately 25.7 acres) with LUCs.
- Alternative 4 – Surface clearance per Alternative 3 with additional subsurface clearance to 4 ft bgs over 3 acres of residential properties in accessible areas to support future construction/maintenance activities with LUCs.
- Alternative 5 – Surface clearance and subsurface clearance per Alternative 4 with additional subsurface clearance of all munitions over 3 acres of residential properties in accessible areas to support future construction/maintenance activities with LUCs.
- Alternative 6 – Surface and subsurface clearance within the boundary of the MRS (approximately 88.8 acres).

A description of each alternative developed for the Aerial Rocket Range Target #1 MRS is provided in Subsection 4.1.1 through Subsection 4.1.3 below. Additionally described below in Subsection 4.1.4 are LTM activities that would be used in combination with the remedial

alternatives following implementation to ensure that the alternative remains effective, and a Five-Year Review that will be conducted as a separate requirement under CERCLA following remedial action. The initial screening performed for the developed alternatives is presented in Subsection 4.2.

4.1.1 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 Aerial Rocket Range Target #1 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 Aerial Rocket Range Target #1 MRS 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. A "no action" alternative is required by the NCP (40 CFR 300.430(e)(6)) to be developed during an FS to provide a baseline for comparison against other contemplated alternatives, and is retained for detailed analysis of potential alternatives for the Aerial Rocket Range Target #1 MRS. There are no costs expected for this alternative as there is no government action and no LTM.

4.1.2 Alternative 2 – Land Use Controls

Risks related to handling munitions may be managed for the Aerial Rocket Range Target #1 MRS through a limited action alternative consisting of various LUCs. Although legal mechanisms of control cannot be imposed for the privately-owned parcels included within the MRS boundary, the implementation of a LUC alternative based on public awareness and education components would provide a means for USACE to coordinate an effort to reduce munitions handling by the property residents, NCF personnel, contractor/maintenance personnel, and recreational users/visitors (i.e., unqualified/trained personnel) through behavior modification. Alternative 2 – LUCs can be used in cases where it may not be possible or practical to physically remove munitions from the Aerial Rocket Range Target #1 MRS or in combination with removal actions if warranted. Therefore, Alternative 2 – LUCs is retained for detailed analysis of potential alternatives for the Aerial Rocket Range Target #1 MRS. Costs for

this alternative are expected to be low to moderate (>$.5M-$1M). Low costs are associated with alternatives <$.5M.

Successful implementation of LUCs is contingent upon the cooperation and active participation of the existing land owners/users, and authorities of the Army and other government agencies to protect the public from explosives hazards. Alternative 2 for the Aerial Rocket Range Target #1 MRS was developed using USACE guidance EP 1110-1-24 for *Establishing and Maintaining Institutional Controls for Ordnance and Explosive Projects* (USACE, 2000) as a reference. Detailed specifications for implementation and LTM would be determined during the remedial design phase of response and documented in a Land Use Control Implementation Plan.

4.1.2.1 Land Use Controls

Three forms of public informational materials for education would be implemented as LUC components under Alternative 2.

1. Development and distribution of informational materials to periodically provide awareness to property owners and town authorities of the presence of munitions, and the DoD educational message for explosive safety referred as “the 3Rs” to be able to recognize, retreat and report any future munitions that are encountered while performing maintenance, improvement, or construction activities on their property.

2. For the general public accessing the MRS for recreational/visiting purposes, installation/maintenance of signage at strategic access points in the MRS would be used to alert users of the MRS history and nature of munitions present, in addition to public safety information (i.e., 3Rs).

3. An educational program is considered under Alternative 2, including providing periodic training on-island for the local community to promote awareness on the munitions characterized at the MRS, and the 3Rs that will be displayed on signage posted in and around the MRS. Attendance will be open to the public, but specifically focused on the local property owners (i.e., residents and NCF), local responders, and town officials.

4.1.3 Munitions Debris Clearance Alternatives

The 938 MD items characterized within the impact area delineated during the RI were recovered between 0 and 96 inches bgs, with an average depth of recovery observed at 2.5 ft bgs, and median depth of 3 ft bgs. Only 3% of the total quantity of MD recovered was discovered at ground surface. Approximately 41% of MD recovered was recovered between ground surface and down to 2 ft bgs, while 95% of the MD recovered was discovered within 4 ft of ground surface. Approximately 27% of the MRS has been developed for residential homes and/or landscaping, while 4% of the MRS is established trails and 4% is beach area accessible to recreational users. Based on the nature and extent of MD characterized during the RI and revised CSM for exposure pathways, the general response action for clearance is contemplated for the Aerial Rocket Range Target #1 MRS according to three potential options for the initial screening of remedial alternatives including:

- Alternative 3 – Surface clearance (25.7 acres) to address the beach, wetlands, NCF trails, and portions of residential properties where ground surface is accessible (excludes portions of the MRS with scrub oak and coastal shrubland vegetation and portion of MRS previously cleared) with LUCs.
- Alternative 4 – Surface clearance per Alternative 3 with additional subsurface clearance to 4 ft bgs over 3 acres of residential properties in accessible areas to support future construction/maintenance activities with LUCs.
- Alternative 5 – Surface and subsurface clearance per Alternative 4 with additional subsurface clearance to 10 ft bgs over the 3 acres of residential properties in accessible areas to support future construction/maintenance activities with LUCs.
- Alternative 6 – Surface and subsurface clearance to 10 ft bgs over 88.8 acres within the boundary of the MRS to address all delineated munitions (excludes existing structures and roadways previously developed, and a section of the MRS that was previously cleared).

The clearance alternatives include a combination of different treatment areas and volumes to provide a range of options to be contemplated. Alternatives 3 through 5 would also include LUCs similar in magnitude to those described in Alternative 2; however, the degree to which LTM is warranted would be lessened with increased removal. Alternative 6 is designed to

contemplate removal of munitions to the greatest extent possible within the MRS to achieve protectiveness without LUCs or LTM following the remedial action.

For Alternative 3, Alternative 4, and Alternative 5, the area that is referred to as "accessible" ground surface includes 25.7 acres within the MRS boundary. However, this area does not account for a recent (2013) removal under contract, which extends work completed in 2011 on one of the residential parcels and was referenced in Subsection 1.2.1.2. The area of the MRS that is "accessible" includes recreational paths, open grasslands/landscaping, the beach, wetlands, and bluffs with low-lying vegetation that could be subject to a surface clearance without removal of any vegetation. This area will be refined to the extent possible as the FS is further developed, and information regarding the 2013 clearance performed under private contract becomes available.

Subsurface clearance contemplated in Alternative 4 and Alternative 5 focus on the highest densities of munitions delineated during the RI in the areas with the highest potential for interaction with the property owners/users. The lateral extent for these removals was considered to extend over the accessible portions of individual properties within the impact area based on consideration of typical activities that may be performed by property owners (utility work, gardening, fence installation, and landscaping, etc.). For Alternative 4, the depth for clearance was determined based on the depth distribution of munitions characterized during the RI which indicated that the bulk of munitions remaining are located within 4 ft of ground surface, and based on consideration of the types of activities that may be performed in the future. For Alternative 5 and Alternative 6, the depth of clearance to address all munitions may extend down to 8 ft based on RI findings and would remove all munitions found to a depth of 10 ft bgs to meet unrestricted requirements for typical residential exposure.

4.1.3.1 Alternative 3 – Surface Clearance (25.7 acres) with Land Use Controls

Surface clearance contemplated under Alternative 3 includes removal of munitions detected on the ground surface and breaching the ground surface across 25.7 acres of the Aerial Rocket Range Target #1 MRS where all receptors have access to surface-located munitions. The area that would be addressed within the MRS is depicted on **Figure 4-1**. This includes all portions of the MRS that are not covered by scrub oak vegetation, such as the beach, wetlands, bluffs,

recreational paths on NCF properties, and grassy portions of residential properties. It is assumed that roadways and driveways would not contain munitions after development and that no MD items were discovered along roadways during the RI providing support for this assumption. Portions of this MRS have been subject to munitions clearance by private contract, and have also been excluded from the estimated area available for a surface clearance. Surface clearance would entail visual searching with analog detection instruments, such as the Schonstedt (flux-gate magnetometer), for assistance. Any MPPEH recovered during the surface clearance would be either blown-in-place (BIP) or consolidated for disposal. The MDAS would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling. The following general tasks would be included in Alternative 3:

- Mobilization
- Site management
- Survey/positioning
- Brush clearing
- Surface munitions detection and removal
- MPPEH disposal (e.g., BIP)
- MDAS waste stream treatment (off-site) disposal
- Site restoration
- Demobilization

Land use controls would be implemented as described in Alternative 2 in Subsection 4.1.2, but LTM would be modified to account for the reduction of munitions source material. Costs for this alternative are expected to be moderate (>$1M - $2.5M).

15.664819 Acres

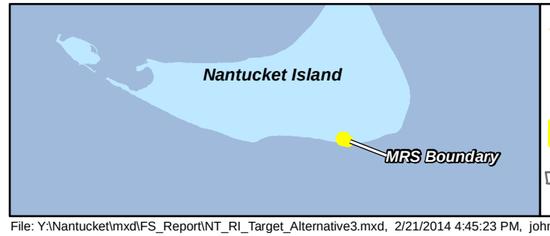
0.274457 Acres

0.40927 Acres

1.000316 Acres

1.030477 Acres

7.352975 Acres



Recreational Trail Clearance Areas

Mowed Grassland/ Beach Clearance Areas (25.7 Acres)

Parcels

MRS Boundary

Area previously cleared under private contract

Coordinate System: UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

WESTON SOLUTIONS

Figure 4-1
Alternative 3
Surface Clearance Area

N

0 190 380 570 Feet

0 70 140 210 Meters

NOTES:
Aerial Data Source: ESRI iCubed Imagery Prime World 2D (2004)
Base Data: USACE (2004); MassGIS (2011)

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4.1.3.2 Alternative 4 – Surface Clearance (25.7 acres) and Subsurface Clearance to 4 ft (3 acres) with Land Use Controls

Surface and subsurface clearance contemplated under Alternative 4 includes removal of munitions detected on the ground surface similar to Alternative 3 (25.7 acres) where all receptors have access to surface-located munitions, and subsurface to 4 ft bgs over 3 acres on residential properties where munitions densities are highest and the probability of interacting with and handling munitions during residential activities is highest within the Aerial Rocket Range Target #1 MRS. As depicted on **Figure 4-2**, the areas included in the clearance area are reasonably open and accessible, where future construction/maintenance activities may be performed such as utility work, fence/shed installations, gardening, and landscaping by the property owners or their contractors. Areas that are excluded include: under existing structures and roadways/driveways as no munitions are likely present following development; areas of dense vegetation cover and the coastal bluffs to preserve these natural resources within the MRS; and the portions of the MRS that have been previously subject to munitions clearance by private contract. Subsurface detection for removal would be performed using digital detection instrumentation such as the EM61-MK2 that employs Time-Domain Electromagnetic Induction (TDEMI) technology. Positioning for the digital instrumentation would be conducted using a Global Positioning System (GPS). Based on **Table 3-2** and **Table 3-3**, these technologies are anticipated to be viable based on MRS-specific munitions and physical characteristics and successful past use at the MRS during the RI.

Some vegetation clearing would likely be performed where needed to gain access during the clearance and to support equipment and staging areas. Anomalies would be reacquired using a robotic total station. Intrusive activities would be performed using both mechanized equipment and hand-tools and restoration of disturbed areas would be required. Any MPPEH recovered during the surface clearance would be either BIP or consolidated for disposal. The MDAS would be consolidated during removal, certified as explosive-free MDAS and disposed off-site for recycling.

15.664819 Acres

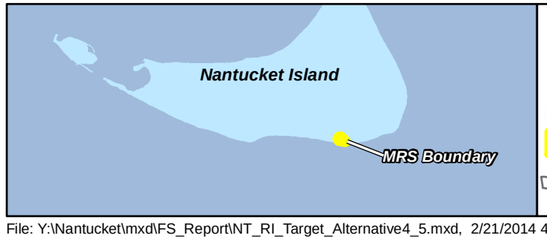
0.274457 Acres

0.40927 Acres

1.000316 Acres

1.030477 Acres

7.352975 Acres



Surface and Subsurface Clearance Areas

Surface Clearance Only

Parcels

MRS Boundary

Area previously cleared under private contract

Coordinate System: UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 190 380 570 Feet

0 70 140 210 Meters

NOTES:
Aerial Data Source: ESRI iCubed Imagery Prime World 2D (2004)
Base Data: USACE (2004); MassGIS (2011)

Figure 4-2
Alternative 4 and Alternative 5 Surface and Subsurface Clearance Area

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The following general tasks would be included in Alternative 4:

- Mobilization
- Site management
- Survey/positioning
- Brush clearing (where needed)
- Surface munitions detection and removal
- DGM and data analysis
- Anomaly reacquisition
- Subsurface munitions removal
- MPPEH disposal (e.g., BIP)
- MDAS waste stream treatment (off-site) disposal
- Site restoration
- Demobilization

Land use controls would be implemented similar to those described in Alternative 2, Subsection 4.1.2, but LTM would be modified to account for the reduction of munitions source material. Costs for this alternative are expected to be moderate to high (>$2.5M-$5M).

4.1.3.3 Alternative 5 – Surface Clearance (25.7 acres) and Subsurface Clearance (3 acres) with Land Use Controls

Surface and subsurface clearance contemplated under Alternative 5 includes removal of munitions detected on the ground surface (25.7 acres) where all receptors have access to surface-located munitions, and subsurface over 3 acres similar to Alternative 4; however, subsurface clearance would be performed to at least 10 ft bgs on residential properties where munitions densities are highest, and the probability of interacting with and handling munitions during residential activities is greatest within the MRS. The area depicted for clearance is the same as Alternative 4 (see **Figure 4-2**), but the volume of munitions that would be addressed is increased as the depth of clearance would not be limited to 4 ft bgs to account for total munitions removal from the area cleared. Subsurface detection for removal would be performed using digital detection instrumentation such as the EM61-MK2 that employs TDEMI technology. Positioning for the digital instrumentation would be conducted using a GPS. Based on **Table 3-2** and **Table 3-3**, these technologies are anticipated to be viable based on MRS-specific munitions and physical characteristics and successful past use at the MRS during the RI.

Extensive vegetation clearing would be performed where needed to gain access during the clearance and to support equipment and staging areas. Anomalies would be reacquired using a robotic total station. Intrusive activities would be performed using both mechanized equipment and hand-tools and restoration of disturbed areas would be required. Any MPPEH recovered during the surface clearance would be either BIP or consolidated for disposal. The MDAS would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling.

Due to the need to achieve detection and total munitions clearance, bulk excavation would need to be performed to provide a grade surface at an elevation for which geophysical survey equipment can reliability detect munitions. A seeding program could be designed to test the capabilities of instrumentation selected for use during the remedial design component to address this issue.

The following general tasks would be included in Alternative 5:

- Mobilization
- Site management
- Survey/positioning
- Brush clearing (where needed)
- Surface munitions detection and removal
- DGM and data analysis
- Anomaly reacquisition
- Subsurface munitions removal
- MPPEH disposal (e.g., BIP)
- MDAS waste stream treatment (off-site) disposal
- Site restoration
- Demobilization

Land use control components would still be implemented as part of the alternative similar to those described in Alternative 2, Subsection 4.1.2, but LTM would be modified to account for the reduction in munitions source material. Costs for this alternative are expected to be moderate to high (>$2.5M-$5M).

4.1.3.4 Alternative 6 – Surface and Subsurface Clearance (88.8 acres)

Surface and subsurface clearance contemplated under Alternative 6 includes removal of all munitions to the greatest extent possible on the ground surface and subsurface to a depth of at least 10 ft bgs over 88.8 acres with the intent of achieving unrestricted exposure following remedial action. The area designed for clearance is depicted on **Figure 4-3** and includes all munitions estimated to remain in the MRS based on the RI. Subsurface detection for removal would be performed using digital detection instrumentation, such as the EM61-MK2 that employs TDEMI technology. Positioning for the digital instrumentation would be conducted using a GPS. Based on **Table 3-2** and **Table 3-3**, these technologies are anticipated to be viable based on MRS-specific munitions and physical characteristics and successful past use at the MRS during the RI.

Significant impacts to natural resources such as vegetation cover and the coastal bluffs would be necessary to access all munitions for clearance and would require extensive restoration efforts.

Anomalies would be reacquired using a robotic total station. Intrusive activities would be performed using both mechanized equipment and hand-tools and restoration of disturbed areas would be required. Any MPPEH recovered during the surface clearance would be BIP or consolidated for disposal. The MDAS would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling.

Surface and Subsurface Clearance Area
Parcels
MRS Boundary
Area previously cleared under private contract

Coordinate System:
UTM, Z19N, NAD83, US Foot

US Army Corps of Engineers

Nantucket Beach Formerly Used Defense Site

N

0 190 380 570 Feet

0 70 140 210 Meters

NOTES:
Aerial Data Source: ESRI iCubed Imagery Prime World 2D (2004)
Base Data: USACE (2004); MassGIS (2011)

Figure 4-3
Alternative 6
Surface and Subsurface Clearance Area

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The following general tasks would be included in Alternative 6:

- Mobilization
- Site management
- Survey/positioning
- Brush clearing (where needed)
- Surface munitions detection and removal DGM and data analysis
- Anomaly reacquisition
- Subsurface munitions removal
- MPPEH disposal (e.g., BIP)
- MDAS waste stream treatment (off-site) disposal
- Site restoration
- Demobilization

Land use control components and LTM costs following clearance activities are not applicable, as the munitions source material will be removed. Costs for this alternative are expected to be high (>$5M).

4.1.4 Long-Term Management

Response actions, such as those contemplated under Alternative 2 through Alternative 5 for this FS, that require some level of LUCs to be left in-place to address residual hazards or risks must be managed in the long-term. Land use control enforcement, review of site conditions, and/or maintenance activities for a remedial alternative may all be considered means of performing LTM following achievement of response complete. One or more of these components may be used to ensure continued protection. Management over the long-term can be performed on a periodic or as-needed basis. LTM should be used until no further response actions are appropriate or anticipated.

For remedial alternatives, it should be noted that in cases where levels are above those that allow for unlimited use and unrestricted exposure (UU/UE) [40 CFR 300.430(f)(4)(ii)], CERCLA requires the review of remedial actions no less than every 5 years following implementation to assure that human health and the environment are being protected. Consistent with this CERCLA requirement, Five-Year Reviews are conducted at FUDS under DERP by USACE (USACE, 2011b).

Because munitions would be left in-place following implementation of all alternatives except for Alternative 6, the LTM requirements for LUC enforcement (i.e., recurring awareness training and review/reproduction of informational materials), maintenance (i.e., signs), on-call UXO support, and Five-Year Reviews would be similar for Alternatives 2 through 5.

4.1.4.1 Land Use Control Enforcement and Maintenance

For Alternatives 2 through 5, which leave munitions in place, based on the nature of LUCs that can be applied to the MRS, enforcement activities would entail performing reviews/reproduction of informational and awareness training materials, and maintenance of signs. Informational materials would be reviewed/updated and redistributed annually for the first 3 years following establishment of LUCs. Sign maintenance would occur annually during LTM.

4.1.4.2 On-Call UXO Support

To ensure the safety of land owners, workers, and the public in the event that future MEC items are found, and in an effort to ensure that the nature of future munitions discoveries can be determined, on-call UXO support will be provided by USACE for a minimum of 4 years. Based on the RI findings, there is a low probability for encountering MEC and, therefore, low potential for an explosive hazard condition. Because a positive identification of MEC should be documented through methods recognized by USACE for disposal of MPPEH (e.g., visual inspection of markings, use of perforator/shape charge to initiate detonation), USACE will coordinate with the property owners and local responders to provide on-call UXO support to respond to munitions that are incidentally encountered at the MRS during the first 4 years of LTM. Providing no future MEC is determined to be present as result of MPPEH that may be discovered, USACE will cease providing on-call UXO support after 4 years. Subsequent effort to respond to discovered munitions reported through the 911 system will resume as the responsibility of trained, local authorities, such as the Massachusetts State Police Bomb Squad, local EOD teams, or the Nantucket Fire Department/police.

To support the FS cost estimate, two response efforts a year are assumed to be performed by USACE based on historical discoveries of reported munitions from the MRS.

4.1.4.3 Five-Year Review

Five-Year Reviews for MRSs determine whether a remedial action continues to minimize explosives safety hazards and continues to be protective of human health, safety, and the environment. Five-Year Reviews would be conducted for all alternatives, except Alternatives 1 and 6, developed for the Aerial Rocket Range Target #1 MRS to address the various amounts of munitions that would be left in-place. Five-Year Reviews to be completed by the Army would include the following general steps:

- Prepare Five-Year Reviews 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 Five-Year Reviews Report.

Five-Year Reviews will continue to be conducted every 5 years until conditions are identified that allow for UU/UE at the MRS. Unlimited use and unrestricted exposure will be considered reached if no MEC has been found at the MRS for at least 4 years following response complete. No unacceptable risk would remain after that point. A Five-Year Review and close-out report will be issued and provided to the State of Massachusetts.

4.2 SCREENING OF POTENTIAL REMEDIAL ALTERNATIVES

The results of the initial screening of potential remedial alternatives assembled for the Aerial Rocket Range Target #1 MRS are present in **Table 4-1** using the three criteria of effectiveness, implementability, and cost that were previously described in Subsection 3.3.1 as part of the technology screening. As a result of the screening, all of the alternatives are being retained for further detailed and comparative analysis in Section 5.

Table 4-1 Screening of Potential Remedial Alternatives for the Aerial Rocket Range Target #1 MRS

Potential Remedial Alternatives		Relative Effectiveness	Implementability (Technical)	Implementability (Administrative)	Relative Cost	Overall Viability
Alternative 1	No Action	**Very Low**	**Easy**	Very Difficult, due to low probability of stakeholder approval	None	Required by NCP to be retained
Alternative 2	LUCs (administrative/ educational) and LTM	**Highly Effective** Based on data collected through the RI for this MRS, the nature and extent of munitions-related hazards has been fully characterized, and process works very well when tailored to the specific populations at risk of exposure through behavior modification. LTM would be conducted to enforce LUCs over the long-term.	**Easy** Limited field work to erect signage, conduct training sessions and/or information meetings for the public. Multiple formats are available for use to convey information to target groups.	Easy to Moderate, depending on stakeholder opinion Execution is limited to primarily administrative functions.	Low to Moderate	High
Alternative 3 [a]	Surface Clearance (25.7 acres) with LUCs and LTM	**Moderately to Highly Effective** Moderately effective because the bulk of munitions on residential properties is located in the subsurface, although surface MD was detected and may be encountered and would be removed under this alternative where the ground surface is accessible to MRS users, and in manner that is unlikely to result in impacts to the environment due to the lack of subsurface work and vegetation removal needed to access the clearance area; LUCs and LTM would be implemented to manage risk over the long-term.	**Easy to Moderately Difficult** Technologies are available that have been used effectively at the MRS to detect and remove munitions; duration of time to complete clearance work would be short (~1 week), without the need for interim environmental protection measures or subsequent restoration effort.	Easy, depending on stakeholder opinion	Moderate	Moderate
Alternative 4 [b]	Surface Clearance (25.7 acres) and Subsurface Clearance to 4 ft (3 acres) with LUCs and LTM	**Highly Effective** Highly effective because the bulk of munitions on residential properties is located in the subsurface down to 4 ft bgs which may be encountered by property owners and would be removed in addition to munitions located on the ground surface throughout the MRS that is accessible to all receptors, in manner that is likely to result in minimal to moderate impacts to the environment due to intrusive work and limited vegetation clearing needed to access the clearance area; LUCs and LTM would be implemented to manage risk over the long-term.	**Moderately Difficult** Technologies are available that have been used effectively at the MRS to detect and remove munitions; duration of time to complete clearance work would be short (~1 month), with moderate interim environmental protection measures and subsequent restoration due to intrusive work and limited vegetation clearing that may be required.	Moderate, depending on stakeholder opinion	Moderate to High	Moderate to High
Alternative 5 [c]	Surface Clearance (25.7 acres) and Subsurface Clearance to 10 ft bgs (3 acres) with LUCs and LTM	**Highly Effective** Highly effective because the munitions located on residential properties in subsurface which may be encountered by property owners would be removed in addition to munitions located on the ground surface throughout the MRS that is accessible to all receptors, in manner that is likely to result in moderate impacts to the environment due to intrusive work and vegetation removal needed to access the clearance area; LUCs and LTM would be implemented to manage risk over the long-term.	**Difficult** Technologies are available and have been used effectively at the MRS to detect and remove munitions; duration of time to complete clearance work would be short (~2 months), with moderate to significant interim environmental protection measures and subsequent restoration due to intrusive work and vegetation clearing and grubbing that may be required. MD during the RI was discovered down to 8 ft bgs, which may require detection and removal in iterative phases based on the reliable detection depth of equipment.	Difficult to Very Difficult, depending on stakeholder opinion	Moderate to High	Low to Moderate
Alternative 6 [d]	Surface Clearance and Subsurface Clearance to 10 ft bgs (88.8 acres)	**Moderately Effective** Moderately effective because the alternative would address all munitions remaining at the MRS and achieve the RAO in the shortest time without future LUCs and LTM, but would incur significant damage to the environment.	**Very Difficult** Clearance at depths greater than 4 ft will require mass excavation operations; duration of time to complete clearance work would be long (~12 months), over 88 acres of land surface would be disturbed including the coastal bluffs and require significant environmental protection, mitigation and/or restoration efforts. MD during the RI was discovered down to 8 ft bgs, which may require detection and removal in iterative phases based on the reliable detection depth of equipment.	Difficult to Very Difficult, due to low probability of stakeholder approval	High	Low

Notes:

LTM – long-term management
LUC – Land use controls
MD – munitions debris
MRS – munitions response site
RAO – remedial action objective
RI – Remedial Investigation

[a] Surface clearance to address beach and NCF trails for recreational use and portions of residential properties where ground surface is accessible for visual and/or instrumented-assisted surveys (i.e., maintained grasslands or low coastal shrub).
[b] Surface clearance areas per Alternative 3 with additional subsurface clearance to 4 ft below ground surface (bgs) on residential properties to support future construction/maintenance activities.
[c] Surface and subsurface clearance areas per Alternative 4 with additional subsurface clearance to 10 ft below ground surface.
[d] Surface clearance with additional subsurface clearance over all portions of MRS where munitions were delineated, excluding existing development (i.e., structures/roadways) and previously cleared portions of the MRS.

SECTION 5

DETAILED ANALYSIS OF ALTERNATIVES

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 Aerial Rocket Range Target #1 MRS is assessed against the NCP evaluation criteria described in Subsection 5.1. The results of the detailed analysis are arrayed to compare the alternatives against each other to identify the remedial alternative that provides the best balance of benefits versus costs. This detailed analysis approach is designed to provide decision-makers sufficient information to adequately compare the alternatives, to select an appropriate remedy for the Aerial Rocket Range Target #1 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 LUCs, engineering controls, or treatment. 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. The ARARs identified for the Aerial Rocket Range Target #1 MRS are summarized in Section 2.

The five "balancing criteria" described below are weighed against each other to determine which alternatives 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/management, and the administrative feasibility of maintaining the LUCs and the potential risk/hazard should they fail.

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 LTM costs for the alternative, as well as periodic costs for Five-Year Reviews to determine the net present value of an alternative. Present value cost is the total cost of an alternative over time, which is estimated both with and without a discount rate applied to demonstrate the impact of a discount rate on the total present value cost and relative amounts of future annual expenditure. The NCP and EPA recommend a discount rate of 7% be incorporated into present value cost estimates. The discounted costs are the values that are used for comparative analysis of remedial alternatives following the detailed analysis. Cost estimates are expected to be accurate within a range of +50% to -30% (EPA, 2000).

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. **State acceptance -** Assesses the technical and administrative issues and concerns the state (MassDEP) may have regarding each of the alternatives evaluated in this FS as well as the preferred alternative presented in the Proposed Plan. State acceptance of an alternative will be evaluated after the Proposed Plan is issued for public comment. Therefore, the state acceptance criterion is not considered in the 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 the FS.

5.2 INDIVIDUAL ANALYSIS OF ALTERNATIVES

The RAO that was established to guide design and evaluation of each of the alternative was presented in Subsection 3.1 and includes the following: to reduce the probability of residents, NCF personnel, contractor/maintenance workers, visitors/trespassers, and recreational users from handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil.

Based on the results of the RI and RAO established for the MRS, the following remedial alternatives which were developed in Section 4 of the FS Report are evaluated for the Aerial Rocket Range Target #1 MRS against the NCP criteria in this Detailed Analysis:

- Alternative 1 – No Action
- Alternative 2 – LUCs and LTM
- Alternative 3 – Surface Clearance (25.7 acres) with LUCs and LTM
- Alternative 4 – Surface Clearance (25.7 acres) and Subsurface Clearance to 4 ft (3 acres) with LUCs and LTM

- Alternative 5 – Surface Clearance (25.7 acres) and Subsurface Clearance to 10 ft bgs (3 acres) with LUCs and LTM
- Alternative 6 – Surface Clearance and Subsurface Clearance to 10 ft bgs (88.8 acres).

The description of each alternative designed in Subsection 4.1 is expanded during the detailed analysis as needed and included in Subsections 5.2.1 through 5.2.5 below.

5.2.1 Alternative 1 – No Action

The No Action alternative for the Aerial Rocket Range Target #1 MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment** - Because no MEC was identified during the RI, a MEC HA was not performed and an explosive risk is not anticipated to be present at the Aerial Rocket Range Target #1 MRS. It is statistically possible for MEC to remain in the MRS; however, based on qualitative assessments such as the significant amount of intrusive work and quantity of recovered MD, it is unlikely MEC is present at ground surface and in the subsurface down to 8 ft. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by qualified/trained personnel and managed appropriately. Existing signage [to be placed as a result of an interim recommendation made by the Army during investigation activities (USACE, 2010)] for the general public will not remain in-place to provide information to assist with recognition of potential munitions, and instructions to retreat and report any discoveries to proper authorities (i.e., the 3R's). Alternative 1 is not protective, and would not eliminate, reduce, or control the threat of human exposure to surface and subsurface munitions and potential for munitions to be handled by unqualified/untrained personnel.

2. **Compliance with ARARs -** There are no action-specific or location-specific ARARs associated with Alternative 1.

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. Exposure to munitions is anticipated to increase over time along the beach where recreational use may occur due to the eroding coastal bluff.

4. **Reduction of TMV of Contaminants Through Treatment -** Alternative 1 would not reduce the TMV of remaining munitions.

5. **Short-Term Effectiveness -** There would be no additional risks to the community, site workers or the environment because there are no construction or operation activities associated with Alternative 1, and it would require no time to complete.

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 following acceptance.

7. **Cost -** Because there are no actions associated with Alternative 1, the total present value cost to perform Alternative 1 is **$0**.

5.2.2 Alternative 2 – Land Use Controls and Long-Term Management

Alternative 2 – LUCs and LTM for the Aerial Rocket Range Target #1 MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment -** Because no MEC was identified during the RI, a MEC HA was not performed and an explosive risk is not anticipated to be present at the Aerial Rocket Range Target #1 MRS. It is statistically possible for MEC to remain in the MRS; however, based on qualitative assessments such as the significant amount of intrusive work and quantity of recovered MD, it is unlikely MEC is present at ground surface and in the subsurface down to 8 ft. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by qualified/trained personnel and managed appropriately. Existing signage [to be placed as a result of an interim recommendation made by the Army during investigation activities (USACE, 2010)] for the general public will remain in-place to provide information to assist with recognition of potential munitions, and instructions to retreat and report any discoveries to proper authorities (i.e., the 3R's). More specific information would be provided to property owners regarding the nature and extent of munitions on their properties, and reminder to follow the 3Rs when munitions are encountered in the future. The LUC informational materials and educational components for risk management recommended in this Aerial Rocket Range Target #1 MRS FS would raise public awareness and modify public behavior during use of the MRS, thus increasing protection of human health. Alternative 2 would provide overall protection by controlling exposure to possible receptors. Alternative 2 would be protective of the environment because no clearing, grubbing, or excavation would be required.

2. **Compliance with ARARs –** Unless an item is identified while conducting on-call UXO support, there are no ARARs associated with Alternative 2 because no actions would be taken on-site to implement LUCs. If MPPEH or confirmed MEC items are identified, requiring on-site disposal operations while conducting on-call UXO support, then 40 CFR Part 264, Subpart X would be an ARAR if a consolidated shot approach is employed in lieu of a BIP technology, and procedures to comply with this requirement would be followed.

3. **Long-Term Effectiveness and Permanence -** Alternative 2 is contingent upon the cooperation and active participation of the government with existing property owners, town authorities, and public using the MRS. The remedial design will specify the individual informational materials and educational programs that will be used to manage risk. The LUC components for risk management that are recommended, as described in Subsection 4.1.2, include printed informational materials such as signs, brochures, fact sheets, and training for the local community on awareness and 3Rs protocol to be followed if munitions are encountered in the future. Under Alternative 2, the recommended LUC components would be implemented by USACE. Maintaining the LUCs in the long term is administratively feasible. If the LUC components fail, there would be a potential risk of untrained/unqualified personnel handling munitions when encountered. LUC enforcement (i.e., awareness training and review/reproduction of informational materials), periodic inspections and maintenance (e.g., signs) would be conducted as LTM to ensure that LUCs remain effective and that the land use has not changed.

4. **Reduction of TMV of Contaminants Through Treatment** – Under Alternative 2 LUCs, mobility of munitions remaining at the MRS would be reduced as a result of modifying human behavior to reduce the probability of interaction with munitions; however, natural processes would still occur. No planned clearance (i.e., reduction in volume) of munitions remaining at the MRS would occur. Given that there were no MEC hazards or MC risks identified during the RI, the requirement to satisfy the preference for treatment as a principal element does not need to be met.

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. Approximately 6 months would be required to establish LUCs associated with Alternative 2.

6. **Implementability -** Providing participation by all stakeholders is achieved, the LUC components recommended in Alternative 2 can be readily implemented by USACE because there are no technical difficulties associated with this alternative, and the materials and services needed to implement this alternative are available. Printed informational materials and training materials (media-based) can be developed and disseminated.

7. **Cost -** The total capital cost for Alternative 2 is $40,349. For estimating purposes, it is assumed that LTM would be conducted for 4 years with a Five-Year Review. The total LTM cost for Alternative 2 is $163,597. The total cost for conducting a Five-Year Review is $36,225. The present value cost to perform Alternative 2 at the Aerial Rocket Range Target #1 MRS is **$206,000** (rounded to the nearest thousand). The cost estimate for Alternative 2 is provided in **Appendix C**.

5.2.3 Alternative 3 – Surface Clearance (25.7 acres) with Land Use Controls and Long-Term Management

Alternative 3 – Surface Clearance with LUCs and LTM for the Aerial Rocket Range Target #1 MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment -** Because no MEC was identified during the RI, a MEC HA was not performed and an explosive risk is not anticipated to be present at the Aerial Rocket Range Target #1 MRS. It is statistically possible for MEC to remain in the MRS; however, based on qualitative assessments such as the significant amount of intrusive work and quantity of recovered MD, it is unlikely MEC is present at ground surface and in the subsurface down to 8 ft. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by qualified/trained personnel and managed appropriately. Existing signage [to be placed as a result of an interim recommendation made by the Army during investigation activities (USACE, 2010)] for the general public will remain in-place to provide information to assist with recognition of potential munitions, and instructions to retreat and report any discoveries to proper authorities (i.e., the 3R's). Surface clearance activities would remove munitions that are visible on the ground surface. Based on the results of the RI, the bulk of munitions remaining within the MRS would likely be in the subsurface as only 3% of the MD items characterized were discovered at ground surface.

   Large portions of the MRS, 67%, are covered in thick vegetation making access to ground surface very difficult. Additionally, approximately 4% of the MRS has been developed and is covered by homes, roadways, and driveways. However, approximately 22% of the MRS is open grasslands (maintained and unmaintained), 4% is established recreational paths, and 7% of the MRS is beach, some of which is accessible to the public. Therefore, a surface clearance in accessible portions of the MRS would provide protectiveness of human health coupled with LUC components by partially eliminating, reducing, and controlling threats to protect human health.

   Surface clearance activities would be protective of the environment because they should not require clearing and grubbing or excavation at the Aerial Rocket Range Target #1 MRS. The munitions would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling in a manner protective of

human health and the environment. Any MPPEH or suspect MEC would be inspected, and if determined safe to move, would be consolidated, treated (i.e., demolition by venting), and removed from the MRS for disposal as certified MDAS resulting in little potential for adverse impacts to environmental resources.

Munitions that are determined to be MPPEH or confirmed MEC rather than MDAS and that are not acceptable to move would be BIP. The 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 environmental 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 and administrative controls (i.e., buffers) could also reduce impacts to environmental resources.

Alternative 3 would provide protection to human health by reducing the volume of munitions that may be potentially mishandled or disposed of improperly when encountered at ground surface only within portions of the MRS that are currently accessible (i.e., beach, recreational paths, open landscaping/grassy areas). The residual munitions would be managed through the implementation of LUC components similar to Alternative 2.

2. **Compliance with ARARs -** Surface clearance of munitions would be performed to comply with all DoD and EPA guidance for munitions response and explosives safety. This work would be conducted in a manner that would cause minimal to no impacts to environmental resources in accordance with 16 U.S.C. §1538(a)(1). If MPPEH or confirmed MEC items are identified requiring on-site disposal operations, then 40 CFR Part 264, Subpart X would be an ARAR if a consolidated shot approach is employed in lieu of a BIP technology. LUCs would not have any associated ARARs, as discussed in Alternative 2. Procedures for ensuring compliance would be developed in the Remedial Design/Remedial Action Work Plans.

3. **Long-Term Effectiveness and Permanence -** Surface clearance of munitions would provide some long-term effectiveness, but the bulk of potentially remaining munitions are likely to be subsurface and would be left in-place. The munitions below the ground surface remaining in the MRS could move to the surface because of erosion, frost heave, or human interaction. LUC components would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the clearance activity. Alternative 3 would provide long-term effectiveness primarily through the implementation of LUC components, but also to limited extent through the removal of surface munitions. If the LUC components fail, there would be a potential risk of untrained/unqualified personnel handling munitions when encountered. LTM for LUC enforcement, inspections and maintenance would be same as Alternative 2.

4. **Reduction of TMV of Contaminants Through Treatment -** Surface clearance would not reduce the number (or volume) of explosives hazards because no MEC has been identified and is not likely to be present. However, the volume of munitions that

is present would be reduced through a surface clearance. The mobility of munitions deeper than ground surface that could occur as a result of erosion, frost heave, or human interaction would not be reduced by a surface clearance. The LUC components would not reduce the volume of potential munitions in the area, but would reduce mobility of any residual munitions post-clearance slightly through modification of behavior to limit human interaction. To the extent that munitions are detected, recovered, and disposed of, its ability to move is reduced. The munitions remaining after a clearance 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 munitions would be removed and treated via off-site recycling for a means of disposal. Any recovered MPPEH or suspect MEC that is discovered with MD during removal would be rendered MDAS on-site prior to certification for off-site disposal via recycling.

5. **Short-Term Effectiveness -** As no MEC has been discovered, munitions clearance is not likely to pose an increase to risk to workers. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Small equipment or material staging areas may be required, but could be constructed within each work area or one designated area within the MRS. No intrusive activities would be performed and no vegetation clearing is anticipated therefore impacts to the environment would be minimal and limited to demolition activities in the unlikely event that MPPEH or suspect MEC is discovered that is consolidated for venting or BIP. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Design/Remedial Action Work Plans. LUC components would not increase risk to workers or the public as described in Alternative 2. It is estimated that surface clearance under Alternative 3 with LUCs would require approximately 6 months to implement.

6. **Implementability -** Surface clearance of MEC is technically and administratively feasible and can be implemented at the Aerial Rocket Range Target #1 MRS, as shown during the RI. Right-of-Entry (ROE) agreements would be needed to access and work within the MRS, but given that activities would be limited to surface actions, obtaining ROEs is anticipated to be feasible with only moderate difficulty. Materials and services to perform Alternative 3 are readily available. LUC components would be implemented as described in Alternative 2.

7. **Cost**— The total capital cost for Alternative 3 is $949,211 with a total LTM cost of $141,385 and total cost for conducting a Five-Year Review of $36,225. The present value cost to perform Alternative 3 at the Aerial Rocket Range Target #1 MRS is **$1,096,000** (rounded to the nearest thousand). The cost estimate for Alternative 3 is provided in **Appendix C**. Costs for LTM activities and periodic costs for Five-Year Reviews are included similar to Alternative 2; however, LTM is slightly decreased to account for the surface clearance that would be performed.

5.2.4 Alternative 4 – Surface Clearance (25.7 acres) and Subsurface Clearance to 4 ft (3 acres) with Land Use Controls and Long-Term Management

Alternative 4 – Surface Clearance and Subsurface Clearance to 4 ft bgs with LUCs and LTM is evaluated relative to the NCP criteria for the Aerial Rocket Range Target #1 MRS as follows:

1. **Overall Protectiveness of Human Health and the Environment -** Because no MEC was identified during the RI, a MEC HA was not performed and an explosive risk is not anticipated to be present at the Aerial Rocket Range Target #1 MRS. It is statistically possible for MEC to remain in the MRS; however, based on qualitative assessments such as the significant amount of intrusive work and quantity of recovered MD, it is unlikely MEC is present at ground surface and in the subsurface down to 8 ft. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by trained authorities and managed appropriately. Existing signage [to be placed as a result of an interim recommendation made by the Army during investigation activities (USACE, 2010)] for the general public will remain in-place to provide information to assist with recognition of potential munitions, and instructions to retreat and report any discoveries to proper authorities (i.e., the 3R's).

   Clearance of munitions at ground surface similar to Alternative 3, with additional subsurface munitions clearance to a depth of 4 ft bgs over 3 acres under Alternative 4 would eliminate a significant amount of munitions within the MRS at the locations where interaction is most likely by the current property owners. Therefore, a surface clearance in accessible portions of the MRS and 4 ft subsurface clearance within residential properties to support future construction/maintenance activities would provide protectiveness of human health coupled with LUCs by partially eliminating, reducing, and controlling threats to protect human health. Although surface clearance activities would be protective of the environment because they should not require clearing and grubbing or excavation at the Aerial Rocket Range Target #1 MRS, subsurface clearance may require the use of heavy equipment and establishment equipment or material staging areas. The munitions would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling in a manner protective of human health and the environment. Any MPPEH or suspect MEC would be inspected, and if determined safe to move, would be consolidated, treated (i.e., demolition by venting) and removed from the MRS for disposal as certified MDAS resulting in little potential for adverse impacts to environmental resources.

   Munitions that are determined to be MPPEH or confirmed MEC rather than MD and that is not acceptable to move would be BIP. The 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 environmental 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 and administrative controls (i.e., buffers) could also reduce impacts to environmental resources.

Alternative 4 would provide protection to human health by reducing the volume of munitions that may be potentially mishandled or disposed of improperly when encountered at ground surface only within portions of the MRS that are currently accessible (i.e., beach, recreational paths, open landscaping/grassy areas) and subsurface where interaction by property owners is most likely in the future. The residual munitions would be managed through the implementation of LUC components similar to Alternative 2.

2. **Compliance with ARARs -** Surface and subsurface clearance of munitions would be performed to comply with all DoD and EPA guidance for munitions response and explosives safety. This work would be conducted in a manner that would cause minimal to no impacts to environmental resources in accordance with 16 U.S.C. §1538(a)(1). If MPPEH or confirmed MEC items are identified requiring on-site disposal operations, then 40 CFR Part 264, Subpart X would be an ARAR if a consolidated shot approach is employed in lieu of a BIP technology. The LUC components would not be associated with any ARARs, as discussed in Alternative 2. Procedures for ensuring compliance would be developed in the Remedial Design/Remedial Action Work Plans.

3. **Long-Term Effectiveness and Permanence -** Clearance of munitions at ground surface, similar to Alternative 3, and in the subsurface over 3 acres down to 4 ft bgs would provide long-term effectiveness by permanently removing munitions from the MRS where exposure risks are greatest. Surface clearance would be performed in accessible portions of the MRS with subsurface clearance performed where future construction/maintenance activities may be performed on residential properties. Alternative 4 would provide long-term effectiveness through the permanent removal of munitions coupled with the implementation of LUC components. If the LUC components fail, there would be a potential risk of untrained/unqualified personnel handling munitions when encountered. LTM for LUC enforcement, inspections and maintenance would be same as Alternative 2.

4. **Reduction of TMV of Contaminants Through Treatment -** Clearance would not reduce the number (or volume) of explosives hazards because no MEC has been identified and is not likely to be present. However, the volume of munitions that is present would be reduced through surface and subsurface clearance. The mobility of munitions deeper than ground surface that could occur as a result of erosion, frost heave, or human interaction would be reduced in the areas where subsurface clearance is performed. LUCs would not reduce the volume of potential munitions in the area, but would reduce mobility of residual munitions post-clearance slightly through modification of behavior to limit human interaction. To the extent that munitions are detected, recovered, and disposed of, its ability to move is reduced. The munitions remaining after a clearance activity would maintain its ability to move,

based on the physical processes described above. Alternative 4 satisfies the statutory preference for treatment as a principal element of the remedy because surface and subsurface munitions would be removed and treated via off-site recycling for a means of disposal. Any recovered MPPEH or suspect MEC that is discovered with MD during removal would be rendered MDAS on-site prior to certification for off-site disposal via recycling.

5. **Short-Term Effectiveness -** As no MEC has been discovered, munitions clearance is not likely to pose an increase to risk to workers. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Limited equipment or material staging areas would be required, and may need to be established along the periphery of the work area to allow access. Limited vegetation clearing may be required. Impacts to the local residents and public will occur during intrusive activities due to the need to excavate within an exclusion zone based on the MGFD. Intrusive activities would be performed in a controlled manner that reduces the potential for negative environmental impacts as mass excavation should not be required. Minimal environmental impacts and to the public may occur during demolition activities in the unlikely event that MPPEH or suspect MEC is discovered that is consolidated for venting or BIP. Procedures for minimizing, reducing, or mitigating negative effects would be developed in the Remedial Design/Remedial Action Work Plans. Land use controls would not increase risk to workers or the public as described in Alternative 2. It is estimated that surface and subsurface clearance under Alternative 4 with LUCs would require approximately 12 months to implement.

6. **Implementability -** Surface and subsurface clearance of MEC is technically and administratively feasible and can be implemented at the Aerial Rocket Range Target #1 MRS, as shown during the RI. ROE agreements would be needed to access and work within the MRS, and since activities would impact both ground surface and subsurface soil up to 4 ft bgs, obtaining ROEs is anticipated to be feasible but difficult. Specific procedures would need to be developed to manage impacts to environmental resources. Materials and services to perform Alternative 4 are readily available. Land use controls would be implemented as described in Alternative 2.

7. **Cost -** The total capital cost for Alternative 4 is $2,389,073 with a total LTM cost of $119,174 and total cost for conducting a Five-Year Review of $36,225. The present value cost to perform Alternative 4 at the Aerial Rocket Range Target #1 MRS is **$2,517,000** (rounded to the nearest thousand). The cost estimate for Alternative 4 is provided in **Appendix C.** Costs for LTM activities and periodic costs for Five-Year Reviews are included similar to Alternative 2, however LTM is moderately decreased to account for the surface and subsurface clearance that would be performed.

5.2.5 Alternative 5 – Surface Clearance (25.7 acres) and Subsurface Clearance to 10 ft bgs (3 acres) with Land Use Controls and Long-Term Management

Alternative 5 – Surface Clearance and Subsurface Clearance to 10 ft bgs (3 acres) with LUCs and LTM is evaluated relative to the NCP criteria for the Aerial Rocket Range Target #1 MRS as follows:

1. **Overall Protectiveness of Human Health and the Environment** - Because no MEC was identified during the RI, a MEC HA was not performed and an explosive risk is not anticipated to be present at the Aerial Rocket Range Target #1 MRS. It is statistically possible for MEC to remain in the MRS; however, based on qualitative assessments such as the significant amount of intrusive work and quantity of recovered MD, it is unlikely MEC is present at ground surface and in the subsurface down to 8 ft. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by qualified/trained personnel and managed appropriately. Existing signage [to be placed as a result of an interim recommendation made by the Army during investigation activities (USACE, 2010)] for the general public will remain in-place to provide information to assist with recognition of potential munitions, and instructions to retreat and report any discoveries to proper authorities (i.e., the 3R's).

   Clearance of munitions at ground surface and in subsurface similar to Alternative 4, with additional subsurface clearance (to 10 ft bgs) for all remaining munitions within the MRS at the locations where interaction is most likely by the current property owners.

   Therefore, a surface clearance in accessible portions of the MRS and full clearance within residential properties to support future construction/maintenance activities would provide protectiveness of human health coupled with LUCs by partially eliminating, reducing, and controlling threats to protect human health. Although surface clearance activities would be protective of the environment because they should not require clearing and grubbing or excavation at the Aerial Rocket Range Target #1 MRS, subsurface clearance may require the use of heavy equipment and establishment equipment or material staging areas. The munitions would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling in a manner protective of human health and the environment. Any MPPEH or suspect MEC would be inspected, and if determined safe to move, would be consolidated, treated (i.e., demolition by venting) and removed from the MRS for disposal as certified MDAS resulting in little potential for adverse impacts to environmental resources.

   Munitions that are determined to be MPPEH or confirmed MEC rather than MD and that is not acceptable to move would be BIP. The 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 environmental 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 and administrative controls (i.e., buffers) could also reduce impacts to environmental resources.

Alternative 5 would provide protection to human health by reducing the volume of munitions that may be potentially mishandled or disposed of improperly when encountered at ground surface only within portions of the MRS that are currently accessible (i.e., beach, recreational paths, open landscaping/grassy areas) and subsurface where interaction by property owners is most likely in the future. The residual munitions would be managed through the implementation of LUC components similar to Alternative 2.

2. **Compliance with ARARs -** Surface and subsurface clearance of munitions would be performed to comply with all DoD and EPA guidance for munitions response and explosives safety. This work would be conducted in a manner that would cause minimal to no impacts to environmental resources in accordance with 16 U.S.C. §1538(a)(1). If MPPEH or confirmed MEC items are identified requiring on-site disposal operations, then 40 CFR Part 264, Subpart X would be an ARAR if a consolidated shot approach is employed in lieu of a BIP technology. Land use controls do not have any associated ARARs, as discussed in Alternative 2. Procedures for ensuring compliance would be developed in the Remedial Design/Remedial Action Work Plans.

3. **Long-Term Effectiveness and Permanence -** Clearance of munitions at ground surface and in the subsurface would provide long-term effectiveness by permanently removing munitions from the MRS where exposure risks are greatest. Surface clearance would be performed in accessible portions of the MRS with subsurface clearance performed where future construction/maintenance activities may be performed on residential properties. Land use controls would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after the clearance activity. Alternative 5 would provide long-term effectiveness through the permanent removal of munitions coupled with the implementation of LUC. If the LUC components fail, there would be a potential risk of untrained/unqualified personnel handling munitions when encountered. LTM for LUC enforcement, inspections and maintenance would be same as Alternative 2.

4. **Reduction of TMV of Contaminants Through Treatment -** Clearance would not reduce the number (or volume) of explosives hazards because no MEC has been identified and is not likely to be present. However, the volume of munitions that is present would be reduced through surface and subsurface clearance. The mobility of munitions deeper than ground surface that could occur as a result of erosion, frost heave, or human interaction would be reduced in the areas where subsurface clearance is performed. Land use controls would not reduce the volume of potential

munitions in the area, but would reduce mobility of residual munitions post-clearance slightly through modification of behavior to limit human interaction. To the extent that munitions are detected, recovered, and disposed of, its ability to move is reduced. The munitions remaining after a clearance activity would maintain its ability to move, based on the physical processes described above. Alternative 5 satisfies the statutory preference for treatment as a principal element of the remedy because surface and subsurface munitions would be removed and treated via off-site recycling for a means of disposal. Any recovered MPPEH or suspect MEC that is discovered with MD during removal would be rendered MDAS on-site prior to certification for off-site disposal via recycling.

5. **Short-Term Effectiveness -** As no MEC has been discovered, munitions clearance is not likely to pose an increase to risk to workers. Impacts to local residents and the public may occur, and extend beyond the immediate work area. Significant equipment and material staging areas would be required to support mass excavation and/or sifting activities, and would need to be established along the periphery of the work area to allow access. Significant vegetation clearing would be required adjacent to the work areas. Impacts to the local residents and public will occur during intrusive activities due to the need to excavate within an exclusion zone based on the MGFD. Intrusive activities would be performed by removing incremental volumes of soil below ground surface to maintain a working surface conducive instrumentation needed to detect anomalies and ensure full clearance of munitions is confirmed to 10 ft bgs. This method of clearance will result in environmental impacts as the area addressed will likely expand beyond currently accessible portions of land, and bulk removal will not preserve any existing ground cover. Extensive restoration will be required with a longer duration of time required for complete recovery of vegetated covering. Environmental impacts and impacts to the public may occur during demolition activities in the unlikely event that MPPEH or suspect MEC is discovered that is consolidated for venting or BIP. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Design/Remedial Action Work Plans. Land use controls would not increase risk to workers or the public as described in Alternative 2. It is estimated that surface and subsurface clearance under Alternative 5 with LUCs would require approximately 18 months to implement.

6. **Implementability -** Surface and subsurface clearance of MEC is technically and administratively feasible and can be implemented at the Aerial Rocket Range Target #1 MRS, as shown during the RI. ROE agreements would be needed to access and work within the MRS, and since activities would impact both ground surface and subsurface soil up to 8 ft bgs, obtaining ROEs is anticipated to be feasible but difficult. Specific procedures would need to be developed to manage impacts to environmental resources. Materials and services to perform Alternative 5 are available, but may require lead time to obtain off-island. Land use controls would be implemented as described in Alternative 2.

7. **Cost**—The total capital cost for Alternative 5 is $2,622,630 with a total LTM cost of $96,962 and total cost for conducting a Five-Year Review of $36,225. The present value cost to perform Alternative 5 at the Aerial Rocket Range Target #1 MRS is **$2,731,000** (rounded to the nearest thousand). The cost estimate for Alternative 5 is provided in **Appendix C.** Costs for LTM activities and periodic costs for Five-Year Reviews are included similar to Alternative 2, however LTM is significantly decreased to account for the surface and subsurface clearance that would be performed.

5.2.6 Alternative 6 – Surface Clearance and Subsurface Clearance to 10 ft bgs (88.8 acres)

Alternative 6 – Surface Clearance and Subsurface Clearance to 10 ft bgs (88.8 acres) is evaluated relative to the NCP criteria for the Aerial Rocket Range Target #1 MRS as follows:

1. **Overall Protectiveness of Human Health and the Environment -** Because no MEC was identified during the RI, a MEC HA was not performed and an explosive risk is not anticipated to be present at the Aerial Rocket Range Target #1 MRS. It is statistically possible for MEC to remain in the MRS; however, based on qualitative assessments such as the significant amount of intrusive work and quantity of recovered MD, it is unlikely MEC is present at ground surface and in the subsurface down to 8 ft. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future which should be handled by qualified/trained personnel and managed appropriately. Existing signage [to be placed as a result of an interim recommendation made by the Army during investigation activities (USACE, 2010)] for the general public will not be required to remain in-place following munitions clearance contemplated as Alternative 6.

   Clearance of munitions at ground surface and in the subsurface over 88.8 acres under Alternative 6 is conceptualized to remove all remaining munitions estimated to remain in the MRS in order to reduce the probably of humans encountering munitions in the future at the MRS to the greatest extent possible. Therefore, a surface and subsurface clearance throughout the entire MRS (excluding under existing homes, roadways/driveways, and previously cleared areas) would provide protectiveness of human health by fully eliminating, reducing, and controlling threats to protect human health.

   However, both surface and subsurface clearance activities would not be protective of the environment because both valuable vegetative cover and the coastal bluffs would be heavily impacted to access and clear all munitions. Full vegetation clearing would be required, and likely grubbing due to mass excavation at the Aerial Rocket Range Target #1 MRS. Heavy equipment, process, and restoration materials would be required and would need established staging areas. This alternative includes intrusive

activity in the coastal bluff along the southern end of the MRS. Increased surface water runoff and soil erosion within the MRS would occur and require significant interim controls and restoration following removal.

The munitions would be consolidated during removal, certified as explosive-free MDAS, and disposed off-site for recycling in a manner protective of human health and the environment. Any MPPEH or suspect MEC would be inspected, and if determined safe to move, would be consolidated, treated (i.e., demolition by venting) and removed from the MRS for disposal as certified MDAS resulting in little potential for adverse impacts.

Munitions that are determined to be MPPEH or confirmed MEC rather than MDAS and that is not acceptable to move would be BIP. The 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 environmental 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 and administrative controls (i.e., buffers) could also reduce impacts to environmental resources.

Alternative 6 would provide protection to human health by reducing the volume of munitions that may be encountered at ground surface and subsurface where interaction by all potential receptors is most likely both now and potentially in the future. However, Alternative 6 would not be protective of the environment.

2. **Compliance with ARARs -** Clearance would be performed to comply with all DoD and EPA guidance for munitions response and explosives safety. If MPPEH or confirmed MEC items are identified requiring on-site disposal operations, then 40 CFR Part 264, Subpart X would be an ARAR if a consolidated shot approach is employed in lieu of a BIP technology. Procedures for ensuring compliance would be developed in the Remedial Design/Remedial Action Work Plans. This work would cause significant impacts to environmental resources, and would not meet 16 U.S.C. §1538(a)(1) under the Endangered Species Act without a waiver.

3. **Long-Term Effectiveness and Permanence -** Clearance of munitions at ground surface and in the subsurface would provide long-term effectiveness by permanently removing munitions from the MRS. Alternative 6 would provide long-term effectiveness through the permanent removal of all remaining munitions without relying on LUCs and/or LTM to maintain the effectiveness of the alternative following implementation.

4. **Reduction of TMV of Contaminants Through Treatment -** Clearance would not reduce the number (or volume) of explosives hazards because no MEC has been identified and is not likely to be present. However, the volume of munitions that is present would be reduced through surface and subsurface clearance. The mobility of munitions deeper than ground surface that could occur as a result of erosion, frost

heave, or human interaction would be reduced across the entire MRS. Alternative 6 satisfies the statutory preference for treatment as a principal element of the remedy because surface and subsurface munitions would be removed and treated via off-site recycling for a means of disposal. Any recovered MPPEH or suspect MEC that is discovered with MD during the clearance would be rendered MDAS on-site prior to certification for off-site disposal via recycling.

5. **Short-Term Effectiveness -** As no MEC has been discovered, munitions clearance is not likely to pose an increase to risk to workers. Impacts to local residents and the public may occur, and extend beyond the immediate work area. Significant equipment and material staging areas would be required to support mass excavation and/or sifting activities, and would need to be established along the periphery of the work area to allow access. Extensive vegetation clearing would be required. Large-scale disturbance of topsoil and vegetation will increase surface water runoff and the effects of wind erosion. Impacts to the local residents and public will occur during intrusive activities due to the need to excavate within an exclusion zone based on the MGFD. Extensive restoration will be required with a very long duration of time required for complete recovery of vegetated covering. Environmental impacts and impacts to the public may occur during demolition activities in the unlikely event that MPPEH or suspect MEC is discovered that is consolidated for venting or BIP. Procedures for minimizing, reducing, or mitigating negative effects would be developed in the Remedial Design/Remedial Action Work Plans. Land use controls would not increase risk to workers or the public as described in Alternative 2. It is estimated that surface and subsurface clearance under Alternative 6 would require approximately 4 years to implement.

6. **Implementability -** Surface and subsurface clearance of MEC is technically feasible but may not be administratively feasible. Removal under Alternative 6 would be very difficult to implement at the Aerial Rocket Range Target #1 MRS given the existing vegetation cover, a valuable natural resource which serves to stabilize soil and the coastal bluffs, as well as to maintain the privacy of the local residents. Specific procedures would need to be developed to manage and/or mitigate impacts to environmental resources and ensure restoration efforts are effective. Materials and services to perform Alternative 6 are available, but may require lead time to obtain off-island. ROE agreements would be needed to access and work within the MRS, and given the extent of work to be performed both at ground surface and in subsurface soil, obtaining ROEs is anticipated to be very difficult and potentially not feasible.

7. **Cost**—The total present value cost to perform Alternative 6 at the Aerial Rocket Range Target #1 MRS is **$22,394,000** (rounded to the nearest thousand). There are no LTM or Five-Year Reviews included for Alternative 6; thus, the present value cost constitutes all capital costs. The cost estimate for Alternative 6 is provided in **Appendix C**.

5.3 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Based on the detailed analysis of remedial alternatives in Subsection 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 6 are compared for the Aerial Rocket Range Target #1 MRS in the discussions below:

1. **Overall Protectiveness of Human Health and the Environment -** Because no MEC was identified during the RI, a MEC HA was not performed and an explosive risk is not anticipated to be present at the Aerial Rocket Range Target #1 MRS. It is statistically possible for MEC to remain in the MRS; however, based on qualitative assessments such as the significant amount of intrusive work and quantity of recovered MD, it is unlikely MEC is present at ground surface and in the subsurface down to 8 ft. Based on the historical reports of munitions-related discoveries within the MRS and quantity of munitions estimated to remain, property owners and MRS users will likely continue to encounter munitions in the future, which should be handled by qualified/trained personnel and managed appropriately. Alternative 1 would not eliminate, reduce, or control the threat of human exposure to surface and subsurface munitions and potential for munitions to be handled by unqualified/untrained personnel and disposed of improperly. Alternative 2 would be protective since it controls exposure through LUCs. Alternative 3 provides protectiveness as munitions would be removed from areas of accessible ground surface; however, RI characterization only observed only 3% of MD findings at ground surface. Alternative 4 and Alternative 5 are protective because subsurface munitions would be removed where exposure is most likely to the property owners in addition to surface munitions throughout portions of the MRS. Alternative 6 is protective of human health because munitions at ground surface and in subsurface would be removed throughout the entire MRS. However, Alternative 6 would not be protective of the environment. Alternative 6 would require extensive planning, management, monitoring of endangered and/or threatened species, restoration, and potential follow-on work to ensure recovery is attained. Similarly, the environmental risks associated with Alternative 5 would be greater than Alternative 4 based on the increased intrusive activity, and very limited for Alternative 3 because only surface-located munitions would be addressed. Alternative 3, Alternative 4, and Alternative 5 would all require LUC components similar to Alternative 2 for any residual munitions following removal actions to control remaining risk of exposure.

2. **Compliance with ARARs -** There are no ARARs associated with Alternative 1 or Alternative 2, and Alternatives 3 through 5 would be implemented and performed to comply with all ARARs. Alternative 3 would require less coordination and planning to avoid potential environmental impacts than Alternative 4 since there is no subsurface clearance included in Alternative 3. Alternative 5 would require slightly more coordination than Alternative 4 since more intrusive work would be performed and the areas addressed may extend into existing vegetation around currently accessible areas. Alternative 6 would be the most intrusive in nature and would not meet the Endangered Species Act regulation 16 U.S.C. §1538(a)(1) identified as an ARAR. A waiver would be required for environmental protection requirements under Alternative 6 based on the extent of disturbance that would be required to achieve clearance of all remaining munitions.

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. Land use controls would provide additional long-term effectiveness and permanence by assisting in managing risk before, during, and after site activities. Surface clearance under Alternative 3 would be slightly more effective and permanent because some of the remaining munitions are likely located at ground surface; however, only 3% of RI recovered MD was at ground surface. Although the subsurface clearance area contemplated as Alternative 4 is the same that would be addressed under Alternative 5 (3 acres), Alternative 5 would be the more effective and permanent alternative as the depth of clearance and total volume of munitions removed would be greater. Under Alternative 6, all munitions would be removed permanently from within the MRS to the greatest extent possible. This includes the lateral extent of MD characterized during the RI, excluding previously cleared portions and under existing structures, roadways and driveways. Therefore, Alternative 6 would be the most effective and permanent remedial alternative over the long-term. Inclusion of LUC components with the partial clearances contemplated as Alternatives 3 through 5 achieves protectiveness in the same manner and within the same time duration needed to achieve the RAO as Alternative 2. However, the LUCs and LTM requirements that would be needed following the clearance alternatives would be reduced based on the amount of munitions removed. Therefore, Alternative 3 would result in less LTM effort than Alternative 2. Both Alternative 4 and Alternative 5 would require slightly less LTM effort than Alternative 3. Although Alternative 5 would be more effective than Alternative 4 over the long-term at reducing future LTM, Alternative 4 would only be slightly less effective based on the anticipated bulk of munitions being located within 4 ft of ground surface. Effort to establish and maintain LUCs would be similar for Alternative 2 and Alternative 3, and slightly less for Alternative 4 and Alternative 5 based on the amount of munitions contemplated for removal. Alternative 6 is not anticipated to require LUCs or LTM following the clearance because all munitions would be removed to the greatest extent possible.

4. **Reduction of TMV of Contaminants Through Treatment -** Alternative 1 would not reduce the TMV of munitions at the Aerial Rocket Range Target #1 MRS. Alternative 2 would be somewhat effective in the reduction of mobility for munitions remaining at the MRS by modifying human behavior through LUCs to reduce the probability of handling munitions when encountered by MRS users. Alternative 3 would be more effective than Alternative 2 relative to a reduction of TMV, but only to the extent that surface munitions are present, detected, recovered, and recycled. Subsurface munitions remaining after implementation of Alternative 3 would maintain ability to move because of natural processes and/or human interaction. Alternative 4 and Alternative 5 would be slightly more effective in reducing the TMV of munitions because all detectable surface and subsurface munitions in the clearance areas would be removed to at least 4 ft bgs, or greater as contemplated under Alternative 5. Alternative 5 is only anticipated to be slightly more effective at reduction of TMV than Alternative 4 based on the results of the RI, which indicated that the bulk of residual munitions are located within 4 ft of ground surface. Alternative 6 provides a significantly greater reduction in TMV that any of the other clearance alternatives as it would result in a permanent removal of the greatest volume of munitions from within the MRS. Alternatives 3, 4, 5 and 6 all satisfy the statutory preference for treatment as a principal element of the remedy because munitions would be removed, certified as MDAS, and disposed off-site via recycling. However, given that there were no MEC hazards or MC risks identified during the RI, the requirement to satisfy the preference for treatment as a principal element does not need to be met.

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 workers at the Aerial Rocket Range Target #1 MRS. Alternatives 3, 4, 5 and 6 would increase risk to the public and workers during clearance of munitions to variable degrees based on the implementation of exclusion zones for intrusive activities (Alternatives 4, 5 and 6 only) and in cases where MPPEH or suspect MEC is encountered requiring treatment on-site to render the item MDAS. Alternatives 1 and 2 would not cause damage to the environment because no clearing, grubbing, or excavation would be required. Alternative 3 is not likely to cause damage to the environment during surface clearance of munitions in accessible portions of the MRS. However, the addition of subsurface clearance activities contemplated under Alternative 4, Alternative 5, and Alternative 6 would cause damage to the environment to variable degrees. Alternative 5 would cause slightly more damage than Alternative 4, but both alternatives would be far less destructive than Alternative 6. Alternative 6 would require extensive interim measures for protection and significantly more restoration than Alternatives 4 or 5 as a result of the larger scale of excavation included and requirements for vegetation clearing and intrusive activity in the bluffs. The time durations required to complete Alternative 2 and Alternative 3 are estimated to be the same at 6 months. Alternative 4 and Alternative 5 would require additional time to perform subsurface clearance, and were estimated to require 12 months and 18 months, respectively, to complete. Alternative 6 would require

approximately 4 years to complete, which is significantly longer than the durations considered under the remaining alternatives.

6. **Implementability -** Alternative 1 would be easily implemented if approved by all stakeholders because it requires no action. The LUCs recommended as Alternative 2 could also be readily implemented because these activities pose no technical difficulties and the materials and services needed are readily available. Clearance of munitions to various depths, similar to the actions proposed in Alternatives 3, 4, 5, and 6, were implemented effectively at the Aerial Rocket Range Target #1 MRS during the RI; however, these alternatives are more difficult to implement than Alternative 2. Alternative 4 would take longer to implement than Alternative 3 as it would be performed over a large area and would require intrusive work to 4 ft bgs in portions of the MRS. Alternative 4 would be slightly more difficult to implement because of the additional administrative work required as a result of the length of the clearance compared to Alternative 3. Alternative 5 would slightly more difficult than Alternative 4 to implement based on administrative logistics and due to the length of time required to complete the clearance. Alternative 6 would be the most technically difficult to implement requiring a very long time to complete the clearance, and added administrative logistics. Specific activities, including awareness training for workers and use of protection procedures/mitigation techniques would be performed to preserve environmental resources during any of the clearance alternatives.

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

   - Alternative 1 = $0
   - Alternative 2 = $206,000
   - Alternative 3 = $1,096,000
   - Alternative 4 = $2,517,000
   - Alternative 5 = $2,731,000
   - Alternative 6 = $22,394,000

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

Table 5-1 presents the comparative summary of the detailed analysis of the alternatives for the Aerial Rocket Range Target #1 MRS. Alternative 2 meets the threshold criteria and most favorably meets the balancing criteria as compared to the remaining alternatives. Alternative 2 can be readily implemented and would be effective over the long-term compared to its cost, whereas Alternatives 3, 4 and 5 are all more difficult to implement and would incur a much greater cost for a slightly greater level of effectiveness over the long term. Both Alternative 1 and Alternative 6 do not meet the threshold criteria for selection.

Table 5-1 Comparative Summary of Detailed Analysis of Remedial Alternatives

	Screening Criterion	Alternative 1: No Action	Alternative 2: Land Use Controls (LUCs) with Long-Term Management (LTM)	Alternative 3: Surface Clearance (25.7 acres) with LUCs and LTM	Alternative 4: Surface (25.7 acres) and Subsurface Clearance to 4ft (3 acres) with LUCs and LTM	Alternative 5: Surface (25.7 acres) and Subsurface Clearance to 10 ft bgs (3 acres) with LUCs and LTM	Alternative 6: Surface and Subsurface Clearance to 10 ft bgs (88.8 acres)
Threshold	Overall Protection of Human Health and Environment	○	●	●	●	●	○
	Compliance with ARARs	●	●	●	●	●	○
Balancing	Long-Term Effectiveness	○	●	●	●	●	●
	Reduction of TMV through Treatment	○	◑	◑	◑	◑	●
	Short-Term Effectiveness	●	●	◑	◑	◑	○
	Implementability	●	●	●	◑	◑	○
	-Technical Feasibility	●	●	●	●	◑	◑
	-Administrative Feasibility	●	●	●	◑	◑	○
	-Availability of Materials and Services	●	●	●	●	◑	◑
	Cost[1]	$0	$206,000	$1,096,000	$2,517,000	$2,731,000	$22,394,000
Modifying[2]	State Acceptance	TBD	TBD	TBD	TBD	TBD	TBD
	Community Acceptance	TBD	TBD	TBD	TBD	TBD	TBD

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

[1] Costs are detailed in Appendix C and are rounded to the nearest thousand.
[2] The modifying criteria will be evaluated following review and input from these parties.
ARAR = applicable or relevant and appropriate requirement
TBD = to be determined
TMV = toxicity, mobility or volume

SECTION 6

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6. REFERENCES

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APPENDIX A

UPDATED CONCEPTUAL SITE MODEL

7. UPDATED CONCEPTUAL SITE MODEL

The preliminary CSM developed prior to the RI addressed MRS 1 as a 1.5-acre potential former burial pit and MRS 2 as a 5,155-acre former Aerial Rocket Range using information available at the time of the SI (see Section 2). The CSM is a dynamic process that is evaluated and revised each time new information is received. The following sections describe significant updates to the CSM that were developed incorporating the results from the RI.

7.1 MUNITIONS AND EXPLOSIVES OF CONCERN EXPOSURE ANALYSIS

This section summarizes the results of the RI with regard to refining the MEC exposure pathway analyses for MRS 1 and MRS 2 to update the CSMs applicable to MEC exposure hazards at each MRS. Each pathway includes a source, activity, access, location, and receptor, with complete, potentially complete, and incomplete exposure pathways identified for each receptor. A pathway is considered complete when a source (MEC) is known to exist and when receptors have access to the MRS while engaging in some activity which results in contact with the source. A pathway is considered potentially complete when a source (MEC) has not been confirmed, but is suspected to exist and when receptors have access to the MRS while engaging in some activity which results in contact with the source. Lastly, an incomplete pathway is any case where at least one of the four components (source, activity, access, or receptors), is determined to be not present within the exposure pathway analysis.

7.1.1 Source

A MEC source is the location where MEC is located or expected to be found. MRS 1 was thought to be a burial site used to dispose of munitions and/or HTW. MRS 1 is co-located within MRS 2 which is a former aerial rocket range fan complex. The range fans were designed around three potential target locations where training may have occurred. Potential Target #1 and Target #3 were depicted on land. Target #2 was depicted in a location underwater. It was unknown following the SI if additional potential MEC source areas were present within the MRS 2.

Survey activities performed during the SI in MRS 1 and around the three potential target areas of MRS 2 did not observe any UXO. Munitions debris was identified in the vicinity of Target #1 in MRS 2 where munitions-related material has been reported historically responded to by EOD and local emergency officials. Although MD was observed near Target #1, the nature and extent of MEC at both MRS 1 and MRS 2 was not fully understood following the SI. Based on the potential MEC burial scenario and use as a former air-to-ground rocket range, the MEC source would be expected to be found on the ground surface and/or subsurface soils. The MEC source may also have been underwater at Target #2 and along the shoreline spanning MRS 2. The anticipated nature of MEC sources included UXO within the range from aerial rocket training, and DMM within the suspected burial pit.

During the RI field activities, no UXO or DMM was identified during either surface or subsurface investigations. A WAA survey and follow on ground reconnaissance activities were used to determine if a potential MEC source was present at Target #1, Target #3, and within the remaining portions of MRS 2. A full coverage DGM survey was also performed across MRS 1 to detect burial features. The only potential MEC source area identified during these activities was at Target #1 where a high density of anomalies were observed during the WAA survey, and MD was identified during prior investigations. The historical reports also indicate that munitions-related items, and potential HE rockets were recovered in this location.

To investigate potential UXO at Target #1, UXO Estimator was used to develop a comprehensive characterization strategy that included 6.52 acres of DGM surveys and the investigation of 1,042 anomalies. During intrusive activities, a significant amount of MD was recovered on the ground surface and in the subsurface up to 8 ft at MRS 2. Single MD items were also recovered in MRS 1 which is directly adjacent to Target #1. No burial features were detected at MRS 1 and no UXO or DMM was recovered in any of the investigations. No UXO or MD was recovered during underwater investigations at Target #2 in MRS 2.

The characterization coverage was determined to be adequate to satisfy the UXO Estimator parameters of 0.5 MEC per acre at a 95% confidence level. Based on these results, a MEC source and therefore an explosive hazard are not present at MRS 1 and MRS 2.

7.1.2 Activity

Activity describes ways that receptors come into contact with a source. Current activities at MRS 1 and MRS 2 includes residential, recreational, and maintenance activities. Residential and maintenance activities may include surface and subsurface soil disturbance. Recreational activities typically involve only foot traffic. Biota activities at MRS 1 and MRS 2 may include foot traffic and/or burrowing activities. There is no anticipated change in land use at MRS 1 and MRS 2.

7.1.3 Access

Access describes the degree to which a MEC source or environment containing MEC is available to potential receptors. There are currently no access restrictions for MRS 1 and MRS 2, although there is significant vegetative cover throughout these areas that physically limits access to both surface and subsurface soils beyond established trails/landscaping. There is no anticipated change to future land use, which will include both foot traffic and surface and subsurface soil disturbance. Although a public beach is not located within the FUDS boundaries and use of the beach is not advocated, the beach is accessible to the public via property owned by NCF. Recreational use is permitted provided users are responsible and discreet. Local property owners indicate that this portion of Nantucket is occasionally used for recreational fishing; however, there are no established beds for shell fishing.

7.1.4 Location

The full coverage WAA survey and subsequent statistical ground-based investigations narrowed the Target #1 footprint to a 97-acre portion of the overall 5,067-acre MRS 2. Target #1 is centered on several residential properties as well as land owned by NCF and the Town of Nantucket. Target #1 also includes the 1.5-acre portion demarcated as MRS 1. Munitions debris was recovered on the ground surface, and up to depths of 8 ft bgs in subsurface soil. Based on the types of rockets used for training, penetration depths may be up to 12.5 ft in depth; however, the average depth of MD observed during the RI was 2.5 to 3 ft bgs within the boundaries of the MRSs.

Additionally, subsurface MD has the potential to readily become accessible at ground surface due to the significant coastal erosion that annually erodes portions of the bluffs away and deposits MD along the beach. Wherever MD is exposed and accessible the potential for receptors to encounter it exists.

7.1.5 Receptors

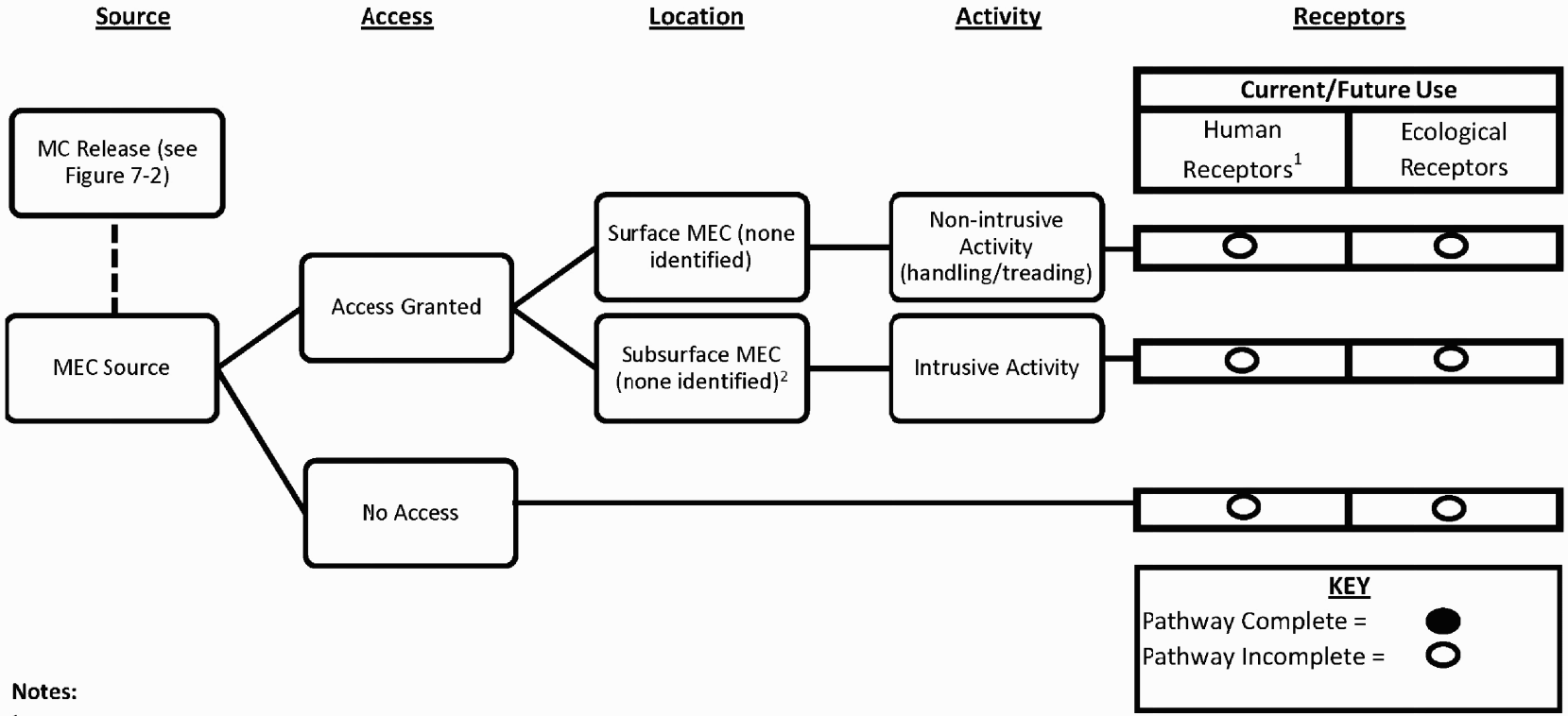
A receptor is an organism (human or ecological) that comes into physical contact with MEC. Human receptors identified for MRS 1 and MRS 2 include both current and anticipated future land users. Human receptors may include trespassers/visitors, residents, employees/volunteers of NCF and Town of Nantucket, and construction workers hired by residents, NCF, and Town of Nantucket.

All of MRS 1 and large portions of MRS 2 are undeveloped. The ecological receptors (biota) of concern for the MRSs developed for SI Screening-Level Ecological Risk Assessment (SLERA) activities were plants, soil, benthic invertebrates, terrestrial-feeding mammals, and terrestrial-feeding birds and did not change as a result of RI activities. All listed and unlisted species of flora and fauna found in the vicinity of the MRSs on Nantucket Island are potential ecological receptors.

7.1.6 Munitions and Explosives of Concern Exposure Conclusions

The information collected during the RI was used to update the preliminary MEC CSM for MRS 1 and MRS 2 and to identify all actual, potentially complete, or incomplete source-receptor interactions for current and anticipated future land uses. The revised MEC exposure pathway analysis is presented in Figure 7-1.

A WAA survey and 24.59 acres of ground-based and underwater geophysical surveys, including the investigation of 1,304 anomalies, were completed within MRS 1 and MRS 2 to assess Target #1, potential Target #2, and potential Target #3, and to locate other potential target areas that were unknown. The only potential MEC source was determined to be at former Target #1. A statistical approach was taken at this location to assess MEC density.



Notes:

[1]Human Receptors include residents, construction/maintenance employees, recreational users/trespassers.

[2]Maximum depth of MD recovered curing the RI was 8 ft bgs; estimated maximum penetration depth based on munition type is 12.5 ft bgs.

ft = feet

bgs = below ground surface

MD = munitions debris (material documented as safe)

MUNITIONS AND EXPLOSIVES OF CONCERN REMEDIAL INVESTIGATION CONCEPTUAL SITE MODEL MRS 1 AND MRS 2

NANTUCKET BEACH FORMERLY USED DEFENSE SITE
NANTUCKET, MA

WESTON SOLUTIONS
CONCORD NEW HAMPSHIRE

US ARMY CORPS OF ENGINEERS

DRAWN	DATE	DES. ENG.	DATE	W.O. NO.
BEG	DEC 2012	MSL	DEC 2012	03886.551.004
CHECKED	DATE	SCALE	REVISION	FIGURE NO.
MSL	DEC 2012	NONE		7-1

No UXO was identified during the investigation of 1,042 anomalies distributed over 6.52 acres of investigation area. Based on these RI results, and the results from the SI field investigation, it is not expected that a MEC source or explosive safety hazard is present at MRS 1 and MRS 2. Given that no UXO or DMM has been identified to date to provide the basis for an explosive safety risk at MRS 1 or MRS 2, there are no current or future exposure pathways present where a receptor may come into contact with a source for MEC. As a result, the revised CSM for MEC identifies incomplete pathways for surface and subsurface soils for all activities undertaken by receptors having access to the MRSs.

7.2 MUNITIONS CONSTITUENTS EXPOSURE ANALYSIS

Although no COPCs or COPECs were identified following the SI and a hazard rating of no known or suspected hazard for MC in environmental media was offered for both MRSs, potentially complete pathways were identified; therefore, additional MC characterization was completed during the RI. Based on these efforts, the findings of the RI were used to update the preliminary CSM for MC to determine if the pathway for MC is complete or incomplete for potential human health and ecological receptors at MRS 1 and MRS 2.

7.2.1 Source

Since no MEC was recovered during the RI constituting a source for MC, potential MC was assessed at MRS 1 and MRS 2 in environmental media found directly in contact with, or potentially affected by, the significant density of MD that was observed (see Technical Memoranda in Appendix A that detail data evaluation, validation, and risk assessment performed for the RI). All MD was recovered and classified as MDAS, and none of the practice rockets were determined to have been fuzed or unfired. Based on the inert nature of practice munitions characterized within the MRS boundaries during the RI, MC of concern includes metals analytes associated with the body/head composition of the rockets including aluminum, barium, iron, magnesium, and zinc. Propellants associated with the rocket motors including nitrocellulose and nitroglycerin would only be a concern in the unlikely event that a rocket motor did not fire during practice.

Surface soil was sampled according to IS methodology to achieve representational characterization of the surface at five geophysical grids determined to have the highest densities of MD identified during the RI. Discrete subsurface sampling was conducted at biased locations selected within each grid to correspond to the maximum observed MD density and characterize soil up to 10 ft bgs. Groundwater was sampled from residential wells constructed within the local aquifer beneath the area of confirmed MD within MRS 1 and MRS 2, and which also correlate to the wells included in the SI groundwater characterization effort.

Analytical data evaluation and risk assessment for potential MC including explosive compounds, metal analytes, and perchlorate (groundwater only) did not identify any elevated concentrations of MC in surface soil, subsurface soil, or groundwater indicating MD was providing a source for contamination.

7.2.2 Release Mechanisms, Exposure Routes, and Mediums

Release of MC to environmental media occurs initially through direct contact at the munitions impact site. At MRS 1 and MRS 2, MD was observed in direct contact with surface soil between 0 and 2 ft bgs, and subsurface soil greater than 2 ft bgs. No sediment or surface water is present in MRS 1. Although present in MRS 2 as a small percentage of total land cover, none of the mapped surface water bodies or wetland sediment areas were investigated during the RI, and are located outside of the preponderance of MD characterized at the former target area. Groundwater was not encountered during any intrusive activities performed during the RI.

Secondary release mechanisms that could affect the fate of MC released to the environment includes dry and wet erosion of surface soil, surface water transport, leaching from soil to groundwater, and volatilization to air. Exposure routes for MC to affect potential receptors include ingestion, incidental ingestion, inhalation, and direct contact based on specific media to receptor pathways.

7.2.3 Receptors

Human receptors identified for MRS 1 and MRS 2 include both current and anticipated future land users that could be potentially affected by MC released within the MRS boundaries. Human receptors may include trespassers/visitors, residents, employees/volunteers of the NCF and Town

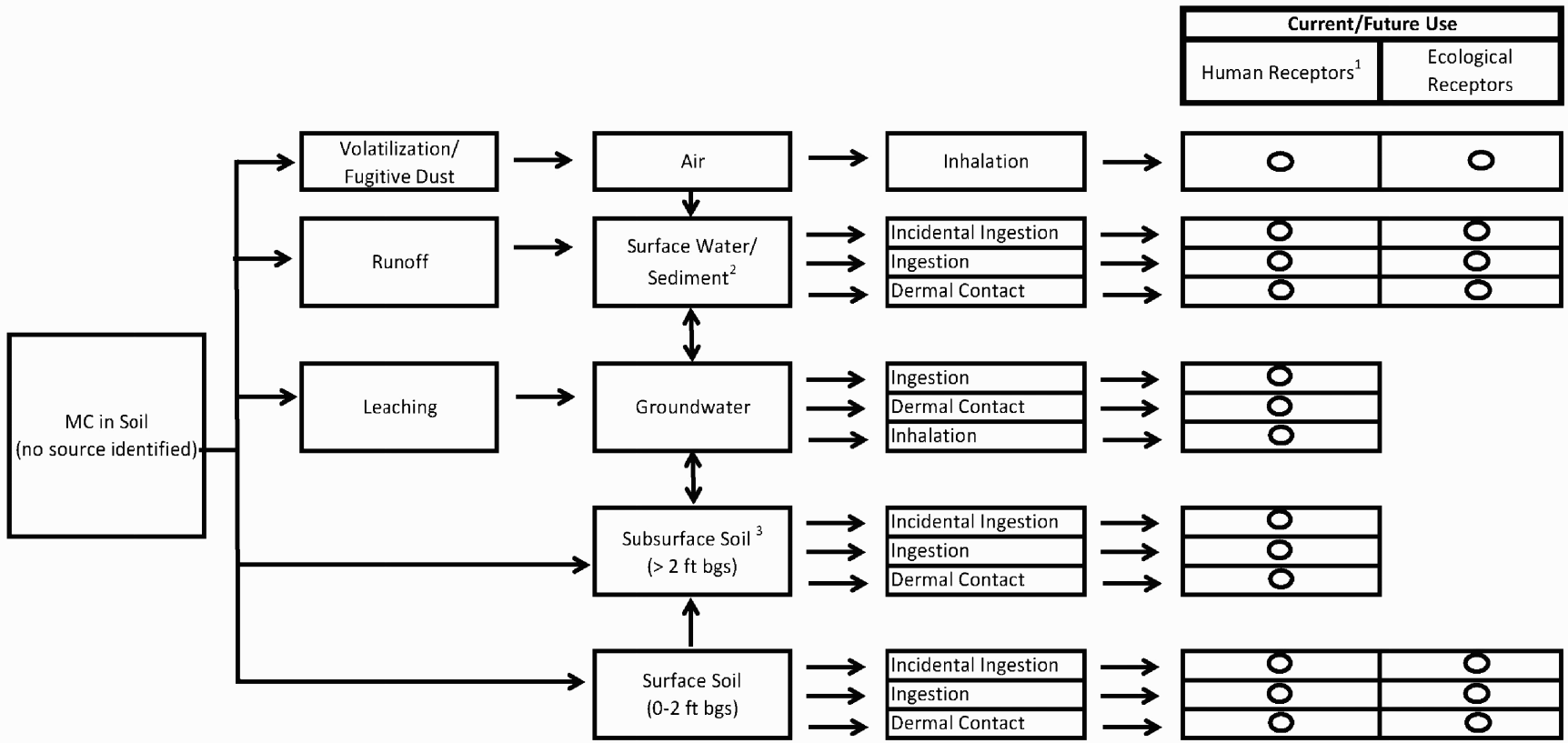
of Nantucket, and construction workers hired by residents, NCF, and Town of Nantucket. In the presence of a source for MC contamination, human receptors are considered at risk for exposure to MC in surface and subsurface soil, sediment/surface water, groundwater, and air. Groundwater below the identified target area in AC-01 that could be affected by a potential subsequent release of MC from soil to groundwater is a known source for drinking water used by local full-time and part-time residents.

All of MRS 1 and large portions of MRS 2 are undeveloped. The ecological receptors (biota) of concern for the MRSs developed for SI SLERA activities were plants, soil, benthic invertebrates, terrestrial-feeding mammals, and terrestrial-feeding birds and did not change as a result of RI activities. All listed and unlisted species of flora and fauna found in the vicinity of the MRSs on Nantucket Island are potential ecological receptors. In the presence of a source for MC contamination, ecological receptors are considered at risk for exposure to MC in surface soil, surface water, sediment, and/or air through direct contact, ingestion, or inhalation of contaminated media. Neither subsurface soil or groundwater were determined to be media with potential to affect ecological receptors.

7.2.4 Munitions Constituents Exposure Conclusions

The information collected during the RI was used to update the preliminary MC CSM for MRS 1 and MRS 2 and to identify all actual, potentially complete, or incomplete source-receptor pathways for current and anticipated future land uses. The revised MC exposure pathway analysis is presented in Figure 7-2.

Sampling performed to support the RI focused on assessment of potential MC contamination released from the significant amount of MD characterized at both MRSs as a MEC source was not identified. The data collected was biased to evaluate a “worst-case” scenario by sampling environmental media in direct contact with the highest densities of MD recovered during the RI, and media with increased human health exposure risks. Risk assessment activities conducted to support the RI employed conservative screening levels and had low potential for uncertainty associated with the findings of no significant risk for all potential receptors.



Notes:

[1]Human Receptors include residents, construction/maintenance employees, recreational users/trespassers.

[2]Surface water/sediment exposure media is not present in MRS 1.

[3]Maximum depth of MD recovered during the RI was 8 ft bgs; estimated maximum penetration depth based on munition type is 12.5 ft bgs.

ft = feet

bgs = below ground surface

MD = munitions debris (material documented as safe)

KEY

Pathway Complete = ●

Pathway Incomplete = ○

MUNITIONS CONSTITUENTS REMEDIAL INVESTIGATION CONCEPTUAL SITE MODEL MRS 1 AND MRS 2

NANTUCKET BEACH FORMERLY USED DEFENSE SITE
NANTUCKET, MA

WESTON SOLUTIONS
CONCORD NEW HAMPSHIRE

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CHECKED	**DATE**	**SCALE**	**REVISION**	**FIGURE NO.**
MSL	DEC 2012	NONE		7-2

Given the lack of any MEC discoveries during the RI to be a source for MC, and on the findings of no significant risk to all receptors for MRS 1 and MRS 2 from soil and groundwater most likely to be affected by the significant amount of MD characterized within the MRSs, the RI findings infer that the pathway for MC is incomplete for human and ecological receptors. See Technical Memoranda in Appendix A that detail data evaluation and risk assessment performed for the RI. No significant risks were identified for any human health or ecological receptors.

APPENDIX B

INSTITUTIONAL ANALYSIS

INSTITUTIONAL ANALYSIS

NANTUCKET BEACH, FORMER NANTUCKET ORDNANCE SITE
A.K.A. TOM NEVERS ROCKET PROJECTILE TARGET;
TOM NEVERS AREA, FORMERLY USED DEFENSE SITE
PROJECT NUMBER D01MA045601
MUNITIONS RESPONSE SITE 1
MUNITIONS RESPONSE SITE 2
NANTUCKET, MASSACHUSETTS

MILITARY MUNITIONS RESPONSE PROGRAM

Contract No.: W912DR-09-D-0006
Delivery Order 0005
DCN No.: MAMMS05-100114-AAVE

Prepared For:

U.S. Army Corps of Engineers
New England District
696 Virginia Road
Concord, Massachusetts 01742

Contracted by:

U.S. Army Corps of Engineers
Baltimore District
10 South Howard Street
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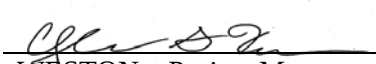
October 2014

Work Order No. 03886.551.004

INSTITUTIONAL ANALYSIS

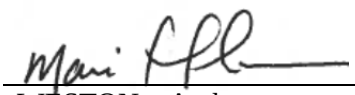
NANTUCKET BEACH, FORMER NANTUCKET ORDNANCE SITE
A.K.A. TOM NEVERS ROCKET PROJECTILE TARGET;
TOM NEVERS AREA, FORMERLY USED DEFENSE SITE
PROJECT NUMBER D01MA045601
MUNITIONS RESPONSE SITE 1
MUNITIONS RESPONSE SITE 2
NANTUCKET, MASSACHUSETTS

MILITARY MUNITIONS RESPONSE PROGRAM



WESTON – Project Manager
Chris Kane, PMP

2 October 2014
Date



WESTON – Author
Marie Swiech-Laflamme

2 October 2014
Date

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LIST OF ACRONYMS

Army	U.S. Army
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DERP	Defense Environmental Restoration Program
DoD	Department of Defense
EP	Engineer Pamphlet
ER	Engineer Regulation
EPA	U.S. Environmental Protection Agency
FS	feasibility study
FUDS	Formerly Used Defense Site
IC	institutional control
LUC	land use control
MassDEP	Massachusetts Department of Environmental Protection
MMRP	Military Munitions Response Program
MRS	munitions response site
NCF	Nantucket Conservation Foundation
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NILB	Nantucket Islands Land Bank
OE	ordnance and explosives
RI	Remedial Investigation
TPP	Technical Project Planning
U.S.	United States
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
USC	United States Code
WESTON®	Weston Solutions, Inc.

1. INTRODUCTION

The Institutional Analysis identifies and analyzes the institutional framework necessary to support the development of an effective land use control (LUC) response action alternative for the Aerial Rocket Range Target #1 Munitions Response Site (MRS) based on institutional controls (ICs) that could be implemented to manage risk related to munitions. The Institutional Analysis was developed to support the Remedial Investigation (RI)/Feasibility Study (FS) being conducted at the Nantucket Beach, Former Nantucket Ordnance Site, a.k.a. Tom Nevers Rocket Projectile Target; Tom Nevers Area, Formerly Used Defense Site (FUDS), Project Number D01MA045601, located on Nantucket Island, Massachusetts. This FUDS will be referred to henceforth as the Nantucket Beach FUDS.

The RI/FS is being performed at the Nantucket Beach FUDS in support of the Defense Environmental Restoration Program (DERP) Military Munitions Response Program (MMRP). Weston Solutions, Inc., (WESTON®) was authorized to conduct the RI/FS through a firm fixed price, Performance-Based Acquisition under the United States (U.S.) Army Corps of Engineers (USACE), Baltimore District Multiple Award Military Munitions Services Contract W912DR-09-D-006, Delivery Order 0005 (USACE, 2011).

2. METHODOLOGY

Two types of general response actions are typically considered for remedial action at munitions response sites for comparison to a baseline condition of "no action":

- **Risk Management** - Risk Management, which is considered a "limited" action alternative by the U.S. Environmental Protection Agency (EPA), includes various LUC options that rely on legal mechanisms, engineering controls, or administrative functions to control access or to modify human behavior and provide long-term management of risk.

- **Removal Action –** Remaining munitions can be detected and removed from the ground surface and/or below the ground surface. Alternatives for munitions clearance include technologies for detection, positioning for the detection technologies, removal, and disposal.

In accordance with DERP FUDS program guidance, the term LUCs encompasses physical, legal, or administrative mechanisms that restrict the use of, or limit access to, contaminated property in order to reduce risk to human health and the environment. Physical mechanisms encompass a variety of engineered remedies to contain or reduce contamination and physical barriers, such as fences or signs, to limit access to property. The legal mechanisms are generally the same as those used for ICs as discussed in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). The ICs are a subset of LUCs and are primarily legal mechanisms imposed to ensure the continued effectiveness of land use restrictions imposed as part of a remedial decision. Legal mechanisms include restrictive covenants, negative easements, equitable servitudes, and deed notices. Administrative mechanisms include notices, adopted local land use plans and ordinances, construction permitting, or other existing land use management systems that may be used to ensure compliance with use restrictions (USACE, 2004).

Development of LUC components considered for the Aerial Rocket Range Target #1 MRS referred to the USACE Guidance Engineer Pamphlet (EP) 1110-1-24, *Establishing and Maintaining Institutional Controls for Ordnance and Explosive (OE) Projects* (USACE, 2000), and EPA 540/R-09/001, *A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites* (EPA, 2012). The main objective is to design controls that rely on legal mechanisms, physical barriers/warning, or administrative mechanisms, such as construction support or educational components to restrict access and/or modify human behavior to reduce exposure risks. The LUCs should be managed and maintained at the local level whenever possible. For FUDS properties, property owners or state/local government agencies with appropriate authorities (i.e., zoning boards) are often the best candidates for LUC management and enforcement (USACE, 2004). Effectiveness of LUCs is dependent on coordination and willingness to participate in maintenance/enforcement by all stakeholders for the duration that the specific control applies to the MRS.

The methodology used to evaluate potential LUCs focused on reducing the potential for handling munitions at the Aerial Rocket Range Target #1 MRS and included a review of the government institutions and non-government entities that have some form of jurisdiction or ownership of the properties within the MRS. Data was collected from site documentation, public records,

discussions with the project stakeholders at Technical Project Planning (TPP) sessions during the RI/FS and through the development of MRS-specific questionnaires sent to all stakeholders. Once jurisdiction and ownership were determined, information concerning these entities was reviewed, including the following: capabilities, resources, and willingness to participate. During the review of current and future capabilities of ICs, current and future land use and public safety resources were considered. The review and analysis focused on identifying potential controls that could be included in a comprehensive risk management strategy for the Aerial Rocket Range Target #1 MRS to support the FS effort.

3. SCOPE OF EFFORT

The Institutional Analysis was prepared in accordance with U.S. Army (Army) guidance, including MMRP document, *Final Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance* [U.S. Army Environmental Command (USAEC, 2009)], and EP 1110-1-24, *Establishing and Maintaining Institutional Controls for Ordnance and Explosives (OE) Projects* (USACE, 2000). The RI Report has been finalized (WESTON, 2013) and is being followed by a FS report that uses the findings of the RI to evaluate potential remedial alternatives to address risk related to munitions at the Aerial Rocket Range Target #1 MRS. Although no unexploded ordnance or discarded military munitions constituting munitions and explosives of concern with an associated explosive hazard were identified during the RI, munitions debris consisting of inert, practice aerial rockets and associated components were characterized and delineated within a 97-acre impact area. All material was ultimately classified as material documented as safe (WESTON, 2013).

The scope of effort for the Institutional Analysis is to gather information and document which stakeholder entities have jurisdiction over the Aerial Rocket Range Target #1 MRS, and to assess the capability and willingness of these entities to assert ICs that would protect the public from explosive hazards potentially present within the limits of the MRS. More specifically, this report identifies entities that have jurisdiction over the land within the Aerial Rocket Range Target #1 MRS; defines authority, responsibility, capability, resources, and the willingness of each entity to participate in ICs to protect the public from explosive hazards; identifies potential strategies

available to implement access control and/or public safety awareness actions for the property; and, defines and analyzes intergovernmental relationships, joint responsibilities, LUC functions, technical capabilities, funding sources, and recommendations.

4. SELECTION CRITERIA AND REVIEW

Based on relevance to the IC process for the MRS, the following agencies, individuals, and organizations were selected for the Institutional Analysis including: land owners, the Army, the Massachusetts Department of Environmental Protection (MassDEP), and the town/county of Nantucket, Massachusetts. Criteria used to identify these entities included: known jurisdiction as a public agency; authority to assist in implementation; responsibility for the control of land use; known willingness/ability to assist; land ownership; and, known resources and capability to provide public information or education for awareness activities.

Land owners: All land within the MRS boundary is demarcated into privately-owned parcels used for residential or conservation purposes with recreational access permitted within the non-residential properties. This includes portions of the beach along the southern boundary of the MRS. Based on the current property line configuration, there are five residential property owners in addition to the Nantucket Conservation Foundation (NCF) that currently own property within the Aerial Rocket Range Target #1 MRS 97-acre boundary and retain legal jurisdiction over the land. Land use types for parcels that fall within the MRS boundary at the time of the RI/FS within the MRS are summarized in **Table 4-1**.

Table 4-1 MRS Property Summary

Parcel Map and Lot No.*	Acreage	Land Use Type
77 2	3.8	Conservation
77 3.1	11.3	Residential (open space)
76 1	8.5	Conservation
90 9	37.7	Residential
91 1	9.3	Residential
91 118	6.2	Residential
91 119	14.2	Residential
91 2.2	1	Conservation
91 2.4	5.4	Residential
Total	**97.4**	

*Source: (Assessors Online Database for Nantucket, MA, last updated 3 March 2013)

All property owners have been involved in the investigation process through the use of TPP meetings, the securing of right-of-entry agreements, and the inclusion in report distribution for investigations findings for the MRS to date. Findings for the investigations are available to the property owners in hard copy report formats [prepared in accordance with Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements] and electronically. Electronic Geographic Information System data files of investigation findings are also available from USACE and have been provided to NCF for integration into their database of property information. All property owners have been receptive to working with USACE to date and were specifically solicited for capabilities and willingness to participate in LUCs contemplated in the FS. Only one property owner (parcel 91 2.4) responded to USACE's request for information in the Institutional Analysis questionnaire. The property owner indicated a willingness/capability to distribute information provided by USACE, a willingness to allow signs to be posted and maintained on the property, and support of LUCs as part of a remedial alternative, but was not willing/capable to contribute funding for LUCs.

Department of the Army: The Army is the executive agent for the FUDS program, and USACE is the program's executing agent. USACE is the lead agency providing technical oversight and

project management with funding for response actions requested through the Environmental Restoration-FUDS account at the MRS. USACE must comply with the DERP statute [10 United States Code (USC) § 2701 et seq.], CERCLA (42 USC § 9601 et seq.), Executive Orders 12580 and 13016, the NCP, and all applicable Department of Defense (DoD) [e.g., EP 1110-1-18 (USACE, 2006), ER 200-3-1 (USACE, 2004), DoD *Management Guidance for the DERP* (DoD, 2012)] and Army policies in managing and executing the FUDS program (USACE, 2004). Because the land within the MRS is currently privately-owned, USACE has minimal control relative to implementing, maintaining, monitoring, or enforcing ICs.

Massachusetts Department of Environmental Protection: MassDEP is the support agency providing regulatory support for remedial decision-making at the MRS. MassDEP is the state agency responsible for ensuring clean air and water, the safe management of toxics and hazards, the recycling of solid and hazardous wastes, the timely cleanup of hazardous waste sites and spills, and the preservation of wetlands and coastal resources. MassDEP has been fully engaged in the TPP process at the MRS and has provided guidance on all activities performed to date. Based on the response received from solicitations regarding willingness and capability to participate in LUCs at the MRS, MassDEP indicated that the agency would be willing to distribute information provided by USACE and supports LUCs as part of a remedial alternative, but was not willing/capable to contribute to funding for LUCs.

Town of Nantucket: The town of Nantucket officials, responders, and various natural resource agencies have interest/involvement in the FUDS project, which was coordinated throughout the RI/FS. Specifically, Nantucket officials who may be solicited for information about the MRS have been made aware of the findings and progress of investigation at the MRS through routine presentations at town meetings; local responders have been alerted to munitions discovered at the MRS through the 911 system; and, the Nantucket Historical Association has been notified regarding signs to be installed for public information. Based on the response received from solicitations regarding willingness and capability to participate in LUCs at the MRS, the town of Nantucket indicated a capability and willingness to distribute information provided by USACE, including with construction permits issued, willingness to allow signage to be posted and

maintained for public awareness, and support for LUCs as part of a remedial alternative, but was not willing/capable to contribute to funding for LUCs except for reproduction of informational materials. Although not a land owner within the MRS boundary, the Nantucket Islands Land Bank (NILB) owns land in the vicinity of the MRS where the public can access the beach area within the MRS. The NILB was conceived by Nantucket's Planning Commission and was established by a special act of the Massachusetts Legislature in 1983 following adoption by the voters of Nantucket. The NILB acquired land for the purpose of public benefit and was contacted directly for willingness/capabilities regarding sign posting for public awareness/safety. The NILB indicated a capability and willingness to distribute information provided by USACE, a willingness to allow signage to be posted and maintained for public awareness, and support for LUCs as part of a remedial alternative, but was not willing/capable to contribute to funding for LUCs.

5. ACCEPTANCE OF JOINT RESPONSIBILITY

All property owners have been involved in the investigation process through the use of TPP meetings, the securing of right-of-entry agreements, and the inclusion in report distribution for investigations findings for the MRS to date. The LUC components being contemplated in the FS are designed to provide a mechanism that affects human behavior to reduce the risk of encountering munitions remaining at the MRS. LUCs established for the MRS require landowner support to be effective. As indicated above, only two of the landowners responded to the questionnaire developed by USACE to facilitate the Institutional Analysis; therefore, the willingness and capabilities of all landowners is not definitively known.

6. TECHNICAL CAPABILITY

Minimal technical capabilities are needed for the landowners to provide specific awareness to the property users or to limit access to their property. USACE is technically capable of performing all other potential response actions, including support in the form of technical guidance to property owners should they pursue establishing legal mechanisms for their properties to address munitions. MassDEP and the town of Nantucket, including officials and natural resource

agencies, are capable of the limited technical requirements to participate in LUC components established for the MRS.

7. INTERGOVERNMENTAL RELATIONSHIPS

USACE is the lead agency providing technical oversight and project management with funding for response actions requested through the Environmental Restoration-FUDS account at the MRS. MassDEP is the support agency for remedial decision-making at the MRS. Both agencies have worked successfully to perform investigation and response efforts to date. The landowners have control and jurisdiction over the land within the MRS in accordance with land use, ordinance, and zoning rules for the town of Nantucket.

8. STABILITY

The town of Nantucket, USACE, and MassDEP are all considered stable institutions. Although stable with regard to the ability to participate, the landowners' willingness to participate may be affected if the ownership of a parcel changes and becomes considered instable.

9. FUNDING SOURCES

Funding has been provided through the Army FUDS program. Additional funding will be required through the Engineer Regulation (ER)-FUDS account to implement a remedial alternative for the MRS.

With the exception of the town, which was willing to fund reproduction of the government provided materials, none of the stakeholders (one residential property owner, NILB, and MassDEP) that responded to the Institutional Analysis questionnaire provided by USACE indicated that they would be willing to fund IC components for the MRS as part of a remedial alternative.

10. RECOMMENDATIONS

There are no existing LUCs currently at the MRS; however, signage is under development for installation at public access points to provide awareness and public safety information

[i.e., recognize, retreat, and report (the 3Rs)] for the Aerial Rocket Range Target #1 MRS. The signs are being installed based on an interim recommendation made by USACE during a 2010 staff visit (USACE, 2010). The design for the signs is informational in nature and does not include any measure of access control. The signs will require adoption as a component of the final remedial alternative selected for the MRS to remain in place.

All project stakeholders will continue to be involved in the selection of a final remedy and implementation for this MRS in accordance with CERCLA and the NCP. The remedial action objective was established for the Aerial Rocket Range Target #1 MRS FS to reduce the probability of residents, NCF personnel, contractor/maintenance workers, visitors/trespassers, and recreational users handling munitions encountered during residential, construction/maintenance, and recreational activities performed at ground surface and in subsurface soil. The following risk management components have been identified that wholly compose a remedial alternative or have been selected to support an active clearance option being contemplated in the FS: informational materials and educational components to provide awareness and affect human behavior.

Based on the results of the Institutional Analysis, USACE shall manage and execute establishment of all LUC components included in the final remedy selected. Funding will be required through the ER-FUDS account to implement LUCs for the MRS. Regulatory agency support to distribute information provided by USACE can be provided by MassDEP; however, no contribution to funding for LUCs has been granted. The town of Nantucket is willing to distribute information provided by USACE; however, no contribution to funding for LUCs has been granted. Two property owners within the MRS and one adjacent to the boundary that provides access to the area indicated willingness to have signs posted and maintained by USACE on their property; however, they were not willing to participate in funding related to signage.

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APPENDIX C

COST ESTIMATES

Feasibility Study - Alternative Cost Summary
Aerial Rocket Range Target #1 MRS

Site: Nantucket FUDS Aerial Rocket Range Target #1 MRS
Location: Nantucket Beach, Nantucket, MA
Phase: Feasibility Study (-30% to +50%)

Item	Aerial Rocket Range Target #1 Total Alternative Costs (Capital and Periodic)	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
		No Action	Land Use Controls (LUCs) and Long-Term Management (LTM)	Surface Clearance (25.7 acres) with LUCs and LTM	Surface Clearance (25.7 acres) and Subsurface Clearance to 4 ft (3 acres) with LUCs and LTM	Surface Clearance (25.7 acres) and Subsurface Clearance to 10 ft (3 acres) with LUCs and LTM	Surface and Subsurface Clearance (88.8 acres)
1	**Total Site Duration Base (Years)/LTM Period (Years)**	0/0	0/4	.2/4	.4/4	.5/4	5/0
2	**Capital Cost**	$0.00	$40,349	$949,211	$2,389,073	$2,622,630	$22,393,956
3	**Total Long Term Management Cost**	$0.00	$163,597	$141,385	$119,174	$96,962	$0
4	**Five-Year Review Cost**	$0.00	$36,225	$36,225	$36,225	$36,225	$0
	5-Year Present Value Cost (assumes 7% annual discount)	**$0**	**$205,787**	**$1,095,787**	**$2,516,787**	**$2,731,482**	**$22,393,956**

Feasibility Study - Alternative No.: 1 Cost Estimate
Aerial Rocket Range Target #1 MRS
Nantucket Beach, Nantucket, MA
No Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Unit Cost	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	82,689	$0
0110	Explosives Safety Submission	0.00	LS	N/A	N/A	N/A	21,097	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	40,136	$0
0300	Site Management	0.00	WK	0.0	0.0	0.0	28,184	$0
0310	Survey/Positioning	0.00	AC	0.0	0.0	0.0	17,361	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	44,147	$0
0340	Environmental Monitoring and Protection	0.00	AC	0.0	0.0	0.0	15,491	$0
0400	MD Surface Removal	0.00	AC	0.0	0.0	0.0	52,824	$0
0410	MD Removal to Detection Depth (M&D)	0.00	AC	0.0	0.0	0.0	53,342	$0
0420	Digital Geophysical Mapping	0.00	AC	0.0	0.0	0.0	26,893	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	22,637	$0
0440	Anomaly Reacquisition	0.00	AC	0.0	0.0	0.0	5,164	$0
0450	MD Subsurface Removal (DGM)	0.00	AC	0.0	0.0	0.0	53,342	$0
0500	MPPEH BIP	0.00	DY	0.0	0.0	0.0	10,680	$0
0510	Scrap Certification and Disposal	0.00	TN	0.0	0.0	0.0	5,179	$0
0600	Site Restoration	0.00	AC	0.0	0.0	0.0	22,885	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	18,688	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	71,944	$0
0800	Land Use Controls	0.00	LS	N/A	N/A	N/A	31,050	$0
	Sub-Total							$0
	Contingency	15%						$0
	Sub-Total							$0
	Infrastructure Improvements	2%						$0
	Project Management	5%						$0
	Remedial Design (not applicable)	0%						$0
	Construction Management	6%						$0
	Total Capital Cost							**$0**

PERIODIC COSTS:

	Description	Year	Modifier	Unit	Unit Cost	Total
0900	Long Term Management - Informational/Educational Material Distribution	1, 2 and 3	0	LS	12,938	$0
0910	Long Term Management - Sign maintenance	1 - 4	0	LS	10,925	$0
0920	On-call UXO Support	1 - 4	0	EA	20,271	$0
1000	Five Year Review - Year 5	5	0	EA	36,225	$0

PRESENT VALUE ANALYSIS:

	Year	Capital Costs	LTM Periodic Costs	5-Yr Reviews Periodic Costs	Total Cost Per Year	Discount Factor (%)[1]	Present Value
0100-0800	0	$0	$0	$0	$0	1	$0
0900 & 0910 & 0920	1	$0	$0	$0	$0	0.935	$0
0900 & 0910 & 0920	2	$0	$0	$0	$0	0.873	$0
0900 & 0910 & 0920	3	$0	$0	$0	$0	0.816	$0
0910 & 0920	4	$0	$0	$0	$0	0.763	$0
1000	5	$0	$0	$0	$0	0.713	$0
		$0	$0	$0	$0		$0
Total Present Value of Alternative							**$0**

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

Note: [1] Discount Factor of 7% (EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS)

Feasibility Study - Alternative No.: 2 Cost Estimate
Aerial Rocket Range Target #1 MRS
Nantucket Beach, Nantucket, MA
Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Unit Cost	Total
0100	Work Plans	0.00	LS	N/A	N/A	N/A	82,689	$0
0110	Explosives Safety Submission	0.00	LS	N/A	N/A	N/A	21,097	$0
0200	Mobilization	0.00	LS	N/A	N/A	N/A	40,136	$0
0300	Site Management	0.00	WK	0.0	0.0	0.0	28,184	$0
0310	Survey/Positioning	0.00	AC	0.0	0.0	0.0	17,361	$0
0320	Brush Clearing	0.00	AC	0.0	0.0	0.0	44,147	$0
0340	Environmental Monitoring and Protection	0.00	AC	0.0	0.0	0.0	15,491	$0
0400	MD Surface Removal	0.00	AC	0.0	0.0	0.0	52,824	$0
0410	MD Removal to Detection Depth (M&D)	0.00	AC	0.0	0.0	0.0	53,342	$0
0420	Digital Geophysical Mapping	0.00	AC	0.0	0.0	0.0	26,893	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	22,637	$0
0440	Anomaly Reacquisition	0.00	AC	0.0	0.0	0.0	5,164	$0
0450	MD Subsurface Removal (DGM)	0.00	AC	0.0	0.0	0.0	53,342	$0
0500	MPPEH BIP	0.00	DY	0.0	0.0	0.0	10,680	$0
0510	Scrap Certification and Disposal	0.00	TN	0.0	0.0	0.0	5,179	$0
0600	Site Restoration	0.00	AC	0.0	0.0	0.0	22,885	$0
0610	Demobilization	0.00	LS	N/A	N/A	N/A	18,688	$0
0700	Final Report	0.00	LS	N/A	N/A	N/A	71,944	$0
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	31,050	$31,050
	Sub-Total							$31,050
	Contingency	15%						$4,658
	Sub-Total							$35,708
	Infrastructure Improvements	2%						$714
	Project Management	5%						$1,785
	Remedial Design (not applicable)	0%						$0
	Construction Management	6%						$2,142
	Total Capital Cost							**$40,349**

PERIODIC COSTS:

	Description	Year	Modifier	Unit	Unit Cost	Total
	Long Term Management - Informational/Educational					
0900	Material Distribution	1, 2 and 3	1	LS	12,938	$12,938
0910	Long Term Management - Sign maintenance	1 - 4	1	LS	10,925	$10,925
0920	On-call UXO Support	1 - 4	1	EA	20,271	$20,271
1000	Five Year Review - Year 5	5	1	EA	36,225	$36,225

PRESENT VALUE ANALYSIS:

	Year		Capital Costs	LTM Periodic Costs	5-Yr Reviews Periodic Costs	Total Cost Per Year	Discount Factor (%)[1]	Present Value
0100-0800	0		$40,349	$0	$0	$40,349	1	$40,349
0900 & 0910 & 0920	1		$0	$44,134	$0	$44,134	0.935	$41,265
0900 & 0910 & 0920	2		$0	$44,134	$0	$44,134	0.873	$38,529
0900 & 0910 & 0920	3		$0	$44,134	$0	$44,134	0.816	$36,013
0910 & 0920	4		$0	$31,196	$0	$31,196	0.763	$23,803
1000	5		$0	$0	$36,225	$36,225	0.713	$25,828
		sum =	$40,349	$163,597	$36,225	$240,172		$205,787
Total Present Value of Alternative								**$205,787**

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

Note: [1] Discount Factor of 7% (EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS)

Feasibility Study - Alternative No.: 3 Cost Estimate
Aerial Rocket Range Target #1 MRS
Nantucket Beach, Nantucket, MA
MEC Surface Clearance (25.7 acres) with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Unit Cost	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	82,689	$82,689
0110	Explosives Safety Submission	1.00	LS	N/A	N/A	N/A	21,097	$21,097
0200	Mobilization	1.00	LS	N/A	N/A	N/A	40,136	$40,136
0300	Site Management	4.00	WK	1.0	1.0	7.5	28,184	$210,476
0310	Survey/Positioning	25.70	AC	5.0	1.0	1.0	17,361	$17,847
0320	Brush Clearing	25.70	AC	5.0	1.0	1.0	44,147	$45,383
0340	Environmental Monitoring and Protection	25.70	AC	5.0	1.0	1.0	15,491	$15,925
0400	MD Surface Removal	25.70	AC	2.5	1.0	2.1	52,824	$108,607
0410	MD Removal to Detection Depth (M&D)	0.00	AC	0.0	0.0	0.0	53,342	$0
0420	Digital Geophysical Mapping	0.00	AC	0.0	0.0	0.0	26,893	$0
0430	Geophysical Data Analysis	0.00	AC	0.0	0.0	0.0	22,637	$0
0440	Anomaly Reacquisition	0.00	AC	0.0	0.0	0.0	5,164	$0
0450	MD Subsurface Removal (DGM)	0.00	AC	0.0	0.0	0.0	53,342	$0
0500	MPPEH BIP	6.00	DY	1.0	1.0	1.2	10,680	$12,816
0510	Scrap Certification and Disposal	6.50	TN	1.0	1.0	1.3	5,179	$6,733
0600	Site Restoration	25.70	AC	2.5	1.0	2.1	22,885	$47,052
0610	Demobilization	1.00	LS	N/A	N/A	N/A	18,688	$18,688
0700	Final Report	1.00	LS	N/A	N/A	N/A	71,944	$71,944
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	31,050	$31,050
	Sub-Total							$730,443
	Contingency	15%						$109,566
	Sub-Total							$840,010
	Infrastructure Improvements	2%						$16,800
	Project Management	5%						$42,000
	Remedial Design (not applicable)	0%						$0
	Construction Management	6%						$50,401
	Total Capital Cost							**$949,211**

PERIODIC COSTS:

	Description	Year	Modifier	Unit	Unit Cost	Total
0900	Long Term Management - Informational/Educational Material Distribution	1, 2 and 3	0.95	LS	12,938	$12,291
0910	Long Term Management - Sign maintenance	1 - 4	1	LS	10,925	$10,925
0920	On-call UXO Support	1 - 4	0.75	EA	20,271	$15,203
1000	Five Year Review - Year 5	5	1	EA	36,225	$36,225

PRESENT VALUE ANALYSIS:

	Year	Capital Costs	LTM Periodic Costs	5-Yr Reviews Periodic Costs	Total Cost Per Year	Discount Factor (%)[1]	Present Value
0100-0800	0	$949,211	0	$0	$949,211	1	$949,211
0900 & 0910 & 0920	1	$0	$38,419	$0	$38,419	0.935	$35,922
0900 & 0910 & 0920	2	$0	$38,419	$0	$38,419	0.873	$33,540
0900 & 0910 & 0920	3	$0	$38,419	$0	$38,419	0.816	$31,350
0910 & 0920	4	$0	$26,128	$0	$26,128	0.763	$19,936
1000	5	$0	$0	$36,225	$36,225	0.713	$25,828
	sum =	$949,211	$141,385	$36,225	$1,126,821		$1,095,787
Total Present Value of Alternative							**$1,095,787**

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

Note: [1] Discount Factor of 7% (EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS)

Feasibility Study - Alternative No.: 4 Cost Estimate
Aerial Rocket Range Target #1 MRS
Nantucket Beach, Nantucket, MA
MEC Surface Clearance (25.7 acres) and Subsurface Clearance to 4 ft (3 acres) with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Unit Cost	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	82,689	$82,689
0110	Explosives Safety Submission	1.00	LS	N/A	N/A	N/A	21,097	$21,097
0200	Mobilization	1.00	LS	N/A	N/A	N/A	40,136	$40,136
0300	Site Management	1.00	WK	1.0	1.0	21.0	28,184	$593,212
0310	Survey/Positioning	28.70	AC	5.0	1.0	1.1	17,361	$19,931
0320	Brush Clearing	28.70	AC	5.0	1.0	1.1	44,147	$50,681
0340	Environmental Monitoring and Protection	28.70	AC	5.0	1.0	1.1	15,491	$17,784
0400	MD Surface Removal	25.70	AC	2.5	1.0	2.1	52,824	$108,607
0410	MD Removal to Detection Depth (M&D)	0.00	AC	0.0	1.0	0.0	53,342	$0
0420	Digital Geophysical Mapping	3.00	AC	0.5	1.0	1.2	26,893	$32,272
0430	Geophysical Data Analysis	3.00	AC	0.5	1.0	1.2	22,637	$27,165
0440	Anomaly Reacquisition	3.00	AC	0.5	1.0	1.2	5,164	$6,197
0450	MD Subsurface Removal (DGM)	3.00	AC	0.06	1.0	10.0	53,342	$533,419
0500	MPPEH BIP	56.50	DY	1.0	1.0	11.3	10,680	$120,683
0510	Scrap Certification and Disposal	10.00	TN	1.0	1.0	2.0	5,179	$10,358
0600	Site Restoration	28.70	AC	2.5	1.0	2.3	22,885	$52,545
0610	Demobilization	1.00	LS	N/A	N/A	N/A	18,688	$18,688
0700	Final Report	1.00	LS	N/A	N/A	N/A	71,944	$71,944
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	31,050	$31,050
	Sub-Total							$1,838,456
	Contingency	15%						$275,768
	Sub-Total							$2,114,224
	Infrastructure Improvements	2%						$42,284
	Project Management	5%						$105,711
	Remedial Design (not applicable)	0%						$0
	Construction Management	6%						$126,853
	Total Capital Cost							**$2,389,073**

ANNUAL AND PERIODIC COSTS:

	Description	Year	Modifier	Unit	Unit Cost	Total
0900	Long Term Management - Informational/Educational Material Distribution	1, 2 and 3	0.9	LS	12,938	$11,644
0910	Long Term Management - Sign maintenance	1 - 4	1	LS	10,925	$10,925
0920	On-call UXO Support	1 - 4	0.5	EA	20,271	$10,136
1000	Five Year Review - Year 5	5	1	EA	36,225	$36,225

PRESENT VALUE ANALYSIS:

	Year	Capital Costs	LTM Periodic Costs	5-Yr Reviews Periodic Costs	Total Cost Per Year	Discount Factor (%)[1]	Present Value
0100-0800	0	$2,389,073	$0	$0	$2,389,073	1	$2,389,073
0900 & 0910 & 0920	1	$0	$32,704	$0	$32,704	0.935	$30,579
0900 & 0910 & 0920	2	$0	$32,704	$0	$32,704	0.873	$28,551
0900 & 0910 & 0920	3	$0	$32,704	$0	$32,704	0.816	$26,687
0910 & 0920	4	$0	$21,061	$0	$21,061	0.763	$16,069
1000	5	$0	$0	$36,225	$36,225	0.713	$25,828
	sum =	$2,389,073	$119,174	$36,225	$2,544,472		$2,516,787
Total Present Value of Alternative							**$2,516,787**

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

Note: [1] Discount Factor of 7% (EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS)

Feasibility Study - Alternative No.: 5 Cost Estimate
Aerial Rocket Range Target #1 MRS
Nantucket Beach, Nantucket, MA
MEC Surface Clearance (25.7 acres) and Subsurface Clearance (3 acres) with Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Unit Cost	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	82,689	$82,689
0110	Explosives Safety Submission	1.00	LS	N/A	N/A	N/A	21,097	$21,097
0200	Mobilization	1.00	LS	N/A	N/A	N/A	40,136	$40,136
0300	Site Management	1.00	WK	1.0	1.0	23.5	28,184	$663,671
0310	Survey/Positioning	28.70	AC	5.0	1.0	1.1	17,361	$19,931
0320	Brush Clearing	28.70	AC	5.0	1.0	1.1	44,147	$50,681
0340	Environmental Monitoring and Protection	28.70	AC	5.0	1.0	1.1	15,491	$17,784
0400	MD Surface Removal	25.70	AC	2.5	1.0	2.1	52,824	$108,607
0410	MD Removal to Detection Depth (M&D)	0.00	AC	0.0	1.0	0.0	53,342	$0
0420	Digital Geophysical Mapping	3.00	AC	0.5	1.0	1.2	26,893	$32,272
0430	Geophysical Data Analysis	3.00	AC	0.5	1.0	1.2	22,637	$27,165
0440	Anomaly Reacquisition	3.00	AC	0.4	1.0	1.5	5,164	$7,746
0450	MD Subsurface Removal (DGM)	3.00	AC	0.05	1.0	12.0	53,342	$640,103
0500	MPPEH BIP	56.50	DY	1.0	1.0	11.3	10,680	$120,683
0510	Scrap Certification and Disposal	11.00	TN	1.0	1.0	2.2	5,179	$11,394
0600	Site Restoration	28.70	AC	2.5	1.0	2.3	22,885	$52,545
0610	Demobilization	1.00	LS	N/A	N/A	N/A	18,688	$18,688
0700	Final Report	1.00	LS	N/A	N/A	N/A	71,944	$71,944
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	31,050	$31,050
	Sub-Total							$2,018,184
	Contingency	15%						$302,728
	Sub-Total							$2,320,912
	Infrastructure Improvements	2%						$46,418
	Project Management	5%						$116,046
	Remedial Design (not applicable)	0%						$0
	Construction Management	6%						$139,255
	Total Capital Cost							**$2,622,630**

PERIODIC COSTS:

	Description	Year	Modifier	Unit	Unit Cost	Total
0900	Long Term Management - Informational/Educational Material Distribution	1, 2 and 3	0.85	LS	12,938	$10,997
0910	Long Term Management - Sign maintenance	1 - 4	1	LS	10,925	$10,925
0920	On-call UXO Support	1 - 4	0.25	EA	20,271	$5,068
1000	Five Year Review - Year 5	5	1	EA	36,225	$36,225

PRESENT VALUE ANALYSIS:

	Year		Capital Costs	LTM Periodic Costs	5-Yr Reviews Periodic Costs	Total Cost Per Year	Discount Factor (%)[1]	Present Value
0100-0800	0		$2,622,630	$0	$0	$2,622,630	1	$2,622,630
0900 & 0910 & 0920	1		$0	$26,990	$0	$26,990	0.935	$25,235
0900 & 0910 & 0920	2		$0	$26,990	$0	$26,990	0.873	$23,562
0900 & 0910 & 0920	3		$0	$26,990	$0	$26,990	0.816	$22,024
0910 & 0920	4		$0	$15,993	$0	$15,993	0.763	$12,202
1000	5		$0	$0	$36,225	$36,225	0.713	$25,828
		sum =	$2,622,630	$96,962	$36,225	$2,755,817		$2,731,482
Total Present Value of Alternative								**$2,731,482**

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

Feasibility Study - Alternative No.: 6 Cost Estimate
Aerial Rocket Range Target #1 MRS
Nantucket Beach, Nantucket, MA
MEC Surface and Subsurface Clearance (88.8 acres)

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Unit Cost	Total
0100	Work Plans	1.00	LS	N/A	N/A	N/A	82,689	$82,689
0110	Explosives Safety Submission	1.00	LS	N/A	N/A	N/A	21,097	$21,097
0200	Mobilization	1.00	LS	N/A	N/A	N/A	40,136	$40,136
0300	Site Management	1.00	WK	1.0	1.0	266.6	28,184	$7,513,112
0310	Survey/Positioning	88.80	AC	2.5	1.0	7.1	17,361	$123,335
0320	Brush Clearing	88.80	AC	2.5	1.0	7.1	44,147	$313,622
0340	Environmental Monitoring and Protection	88.80	AC	2.5	1.0	7.1	15,491	$110,051
0400	MD Surface Removal Cost Estimate	88.80	AC	2.5	1.0	7.1	52,824	$375,265
0410	MD Removal to Detection Depth (M&D)	0.00	AC	0.0	1.0	0.0	53,342	$0
0420	Digital Geophysical Mapping	88.80	AC	0.5	1.0	35.5	26,893	$955,245
0430	Geophysical Data Analysis	88.80	AC	0.5	1.0	35.5	22,637	$804,074
0440	Anomaly Reacquisition	88.80	AC	0.25	1.0	71.0	5,164	$366,858
0450	MD Subsurface Removal (DGM)	88.80	AC	0.15	1.0	118.4	53,342	$6,315,687
0500	MPPEH BIP	154.00	DY	1.0	1.0	30.8	10,680	$328,941
0510	Scrap Certification and Disposal	66.00	TN	1.0	1.0	13.2	5,179	$68,362
0600	Site Restoration	88.80	AC	2.5	1.0	7.1	22,885	$162,578
0610	Demobilization	1.00	LS	N/A	N/A	N/A	18,688	$18,688
0700	Final Report	1.00	LS	N/A	N/A	N/A	71,944	$71,944
0800	Land Use Controls	1.00	LS	N/A	N/A	N/A	31,050	$31,050
	Sub-Total							$17,702,732
	Contingency	15%						$2,655,410
	Sub-Total							$20,358,142
	Infrastructure Improvements	2%						$407,163
	Project Management	4%						$814,326
	Remedial Design (not applicable)	0%						$0
	Construction Management	4%						$814,326
	Total Capital Cost							**$22,393,956**

PERIODIC COSTS:

	Description	Year	Modifier	Unit	Unit Cost	Total
0900	Long Term Management - Informational/Educational Material Distribution	1, 2 and 3	0	LS	12,938	$0
0910	Long Term Management - Sign maintenance	1 - 4	0	LS	10,925	$0
0920	On-call UXO Support	1 - 4	0	EA	20,271	$0
1000	Five Year Review - Year 5	5	0	EA	36,225	$0

PRESENT VALUE ANALYSIS:

	Year		Capital Costs	LTM Periodic Costs	5-Yr Reviews Periodic Costs	Total Cost Per Year	Discount Factor (%)[1]	Present Value
0100-0800	0 - 4		$22,393,956	$0	$0	$22,393,956	1	$22,393,956
1000	5		$0	$0	$0	$0	0.713	$0
		sum =	$22,393,956	$0	$0	$22,393,956		$22,393,956
Total Present Value of Alternative								**$22,393,956**

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

Note: [1] Discount Factor of 7% (EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS)

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Aerial Rocket Range Target #1 MRS FS Cost Estimate					HO	Field							Subtotal	Subtotal w/MUP	Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	Straight LABOR $	Straight LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	5% OH & 10% Profit	Effort
0100	**Work Plans(WP/APP/SSHP & GSV) (incl. draft, draft-final, & final)**												**$31,493.75**		**$82,688.76**
	QC Manager(ST)	24		51.08	$1,225.92							$1,225.92		$3,677.76	
	Mid Engineer (ST)	100		38.65	$3,865.00							$3,865.00		$11,595.00	
	Regulatory Specialist(ST)	50		44.75	$2,237.50							$2,237.50		$6,712.50	
	Administrative(ST)	60		27.47	$1,648.20							$1,648.20		$4,944.60	
	Associate Geoscientist(ST)	180		30.24	$5,443.20							$5,443.20		$16,329.60	
	CADD/GIS Operator(ST)	80		32.40	$2,592.00							$2,592.00		$7,776.00	
	Project Geophysicist(ST)	120		56.33	$6,759.94							$6,759.94		$20,279.81	
	SUXOS(ST)	30		47.73	$1,432.00							$1,432.00		$4,295.99	
	Outside Reproduction	30	EA	150.00							$4,500.00	$4,500.00		$5,175.00	
	Shipping	30	EA	25.00							$750.00	$750.00		$862.50	
	ACAD Recovery	80	HR	13.00						$1,040.00		$1,040.00		$1,040.00	
0110	**Explosives Safety Submission (incl. draft, draft-final, & final)**												**$7,760.65**		**$21,096.94**
	QC Manager(ST)	6		51.08	$306.48							$306.48		$919.44	
	Mid Engineer (ST)	12		38.65	$463.80							$463.80		$1,391.40	
	Regulatory Specialist(ST)	12		44.75	$537.00							$537.00		$1,611.00	
	Administrative(ST)	20		27.47	$549.40							$549.40		$1,648.20	
	Associate Geoscientist(ST)	0		30.24	$0.00							$0.00		$0.00	
	CADD/GIS Operator(ST)	20		32.40	$648.00							$648.00		$1,944.00	
	Project Geophysicist(ST)	60		56.33	$3,379.97							$3,379.97		$10,139.90	
	SUXOS(ST)	15		47.73	$716.00							$716.00		$2,147.99	
	Outside Reproduction	15	EA	50.00							$750.00	$750.00		$862.50	
	Shipping	15	EA	10.00							$150.00	$150.00		$172.50	
	ACAD Recovery	20	HR	13.00						$260.00		$260.00		$260.00	
0200	**Mobilization (1 UXO Team -10hrs mob, 10hrs demob, per diem)**												**$27,165.83**		**$40,135.58**
	UXO Tech II (6 ea) (ST)	96	HR	36.29		$3,483.42						$3,483.42		$6,966.84	
	UXO Tech II (6 ea) (OT)	24	HR	54.43		$1,306.28						$1,306.28		$2,612.56	
	UXO Tech III (ST)	16	HR	42.73		$683.73						$683.73		$1,367.46	
	UXO Tech III (OT)	4	HR	64.10		$256.40						$256.40		$512.80	
	UXOSO/QCS (ST)	16	HR	43.73		$699.73								$1,399.46	
	UXOSO/QCS (OT)	4	HR	65.60		$262.40								$524.80	
	SUXOS (ST)	16	HR	47.73		$763.73								$1,527.46	
	SUXOS (OT)	4	HR	71.60		$286.40								$572.80	
	Sub: Mob Misc Equipment	2	EA	500.00					$1,000.00			$1,000.00		$1,150.00	
	Misc ODCs	2	DY	100.00							$200.00	$200.00		$230.00	
	Equip & Supplies	2	LS	1,000.00							$2,000.00	$2,000.00		$2,300.00	
	Pickup Truck 4x4 w/FOG (2 ea)	4	DY	200.00				$800.00				$800.00		$920.00	
	Per Diem	12	DY	328.00			$3,936.00					$3,936.00		$4,526.40	
	Mob/Demob Allowance per Person	9	EA	1,500.00							$13,500.00	$13,500.00		$15,525.00	

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Aerial Rocket Range Target #1 MRS FS Cost Estimate					HO	Field							Subtotal	Subtotal w/MUP	Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	Straight LABOR $	Straight LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	5% OH & 10% Profit	Effort
0300	**Site Management (5-10hr days, per diem @ 7 dys/wk)**												**$19,252.65**		**$28,183.75**
	UXOSO (ST)	40	HR	43.73		$1,749.33						$1,749.33		$3,498.66	
	UXOSO (OT)	10	HR	65.60		$656.00						$656.00		$1,312.00	
	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	47.73		$1,909.33						$1,909.33		$3,818.66	
	SUXOS (OT)	10	HR	71.60		$716.00						$716.00		$1,432.00	
	Computer	5	DY	10.00				$50.00				$50.00		$57.50	
	Copier/Fax	5	DY	5.00				$25.00				$25.00		$28.75	
	Printer	5	DY	10.00				$50.00				$50.00		$57.50	
	Internet Service	5	DY	5.00					$25.00			$25.00		$28.75	
	Generator w/FOG	5	DY	40.00				$200.00				$200.00		$230.00	
	Port-a-John	5	DY	10.00				$50.00				$50.00		$57.50	
	Storm Detector	5	DY	80.00				$400.00				$400.00		$460.00	
	Schonstedt	5	DY	30.00				$150.00				$150.00		$172.50	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	200.00				$2,800.00				$2,800.00		$3,220.00	
	SUV 4x4 w/FOG	7	DY	90.00				$630.00				$630.00		$724.50	
	Storage Box (CONEX)	5	DY	15.00				$75.00				$75.00		$86.25	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Cell Phone	5	DY	5.00							$25.00	$25.00		$28.75	
	Project Phone Service	5	DY	10.00							$50.00	$50.00		$57.50	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$287.50	
	Radios	5	DY	20.00							$100.00	$100.00		$115.00	
	Mechanics Tool Kit	5	DY	5.00							$25.00	$25.00		$28.75	
	Demolition Tool Kit	5	LS	20.00							$100.00	$100.00		$115.00	
	Per Diem	21	DY	328.00			$6,888.00					$6,888.00		$7,921.20	
0310	**Survey/Positioning (UXO Tech II escort required for 2-man survey crew, 5-10hr dys, per diem @ 7 dys/wk)**												**$13,621.71**		**$17,361.32**
	UXO Tech II (ST)	40	HR	36.29		$1,451.42						$1,451.42		$2,902.85	
	UXO Tech II (OT)	10	HR	54.43		$544.28						$544.28		$1,088.57	
	Survey Sub	5	DY	1,500.00					$7,500.00			$7,500.00		$8,625.00	
	SUV 4x4 w/FOG	7	DY	90.00				$630.00				$630.00		$724.50	
	Surveyors Kit	5	DY	100.00				$500.00				$500.00		$575.00	
	Misc Small Tools/Equip	5	DY	50.00				$250.00				$250.00		$287.50	
	Computer	5	DY	10.00				$50.00				$50.00		$57.50	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Schonstedt	5	DY	10.00							$50.00	$50.00		$57.50	
	FOG	0	GL	5.00							$0.00	$0.00		$0.00	
	Radios	5	DY	20.00							$100.00	$100.00		$115.00	
	Per Diem	7	DY	328.00			$2,296.00					$2,296.00		$2,640.40	

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Aerial Rocket Range Target #1 MRS FS Cost Estimate					HO	Field							Subtotal	Subtotal w/MUP	Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	Straight LABOR $	Straight LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	5% OH & 10% Profit	Effort
0320	**Brush Clearing (5-10hr dys, per diem @ 7 dys/wk)**												**$36,052.75**		**$44,147.30**
	UXO Tech II (ST)	40	HR	36.29		$1,451.42						$1,451.42		$2,902.85	
	UXO Tech III (ST)	40	HR	42.73		$1,709.33						$1,709.33		$3,418.66	
	Brush Cutter, Power	5	DY	15.00				$0.00				$0.00		$0.00	
	Chain Saw	5	DY	15.00				$0.00				$0.00		$0.00	
	Gator ATV	5	DY	250.00				$1,250.00				$1,250.00		$1,437.50	
	FOG	50	GL	5.00							$250.00	$250.00		$287.50	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Misc Small Tools/Equip	5	DY	50.00				$0.00				$0.00		$0.00	
	Brush Clearing Sub	5	DY	5,000.00					$25,000.00			$25,000.00		$28,750.00	
	Pickup Truck 4x4 w/FOG	7	DY	200.00				$1,400.00				$1,400.00		$1,610.00	
	Radios	5	DY	20.00							$100.00	$100.00		$115.00	
	Schonstedt	5	DY	10.00							$50.00	$50.00		$57.50	
	Per Diem	14	DY	328.00			$4,592.00					$4,592.00		$5,280.80	
0340	**Env. Monit./Protection (1 Biologist & 1 UXO Tech II)**												**$11,995.71**		**$15,491.42**
	Env. Monitoring and Protection (1 Biologist)	5	DY	1,500.00					$7,500.00			$7,500.00		$8,625.00	
	UXO Tech II (ST)	40	HR	36.29		$1,451.42						$1,451.42		$2,902.85	
	UXO Tech II (OT)	10	HR	54.43		$544.28						$544.28		$1,088.57	
	Env. Protection	5	DY	500.00					$2,500.00			$2,500.00		$2,875.00	
0400	**MD Surface Removal (5-10hr dys, per diem @ 7 dys/wk)**												**$35,346.57**		**$52,824.45**
	UXO Tech II (6 ea) (ST)	240	HR	36.29		$8,708.54						$8,708.54		$17,417.09	
	UXO Tech II (6 ea) (OT)	60	HR	54.43		$3,265.70						$3,265.70		$6,531.41	
	UXO Tech III (ST)	40	HR	42.73		$1,709.33						$1,709.33		$3,418.66	
	UXO Tech III (OT)	10	HR	64.10		$641.00						$641.00		$1,282.00	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	200.00				$2,800.00				$2,800.00		$3,220.00	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$230.00	
	FOG	50	GL	5.00							$250.00	$250.00		$287.50	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Schonstedt (6 ea)	30	DY	10.00							$300.00	$300.00		$345.00	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$287.50	
	Hand Held PDA (2)	10	DY	50.00							$500.00	$500.00		$575.00	
	Radios	5	DY	20.00							$100.00	$100.00		$115.00	
	Computer	5	DY	10.00				$50.00				$50.00		$57.50	
	Misc. H&S Equip	5	DY	50.00				$250.00				$250.00		$287.50	
	Per Diem	49	DY	328.00			$16,072.00					$16,072.00		$18,482.80	
0410	**MEC Removal to Detection Depth (M&D) (5-10hr dys, per diem @ 7 dys/wk)**												**$35,796.57**		**$53,341.95**
	UXO Tech II (6 ea) (ST)	240	HR	36.29		$8,708.54						$8,708.54		$17,417.09	
	UXO Tech II (6 ea) (OT)	60	HR	54.43		$3,265.70						$3,265.70		$6,531.41	
	UXO Tech III (ST)	40	HR	42.73		$1,709.33						$1,709.33		$3,418.66	
	UXO Tech III (OT)	10	HR	64.10		$641.00						$641.00		$1,282.00	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	200.00				$2,800.00				$2,800.00		$3,220.00	
	Gator ATV	5	DY	40.00				$200.00				$200.00		$230.00	
	FOG	100	GL	5.00							$500.00	$500.00		$575.00	
	Schonstedt (6 ea)	30	DY	10.00							$300.00	$300.00		$345.00	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$287.50	
	Hand Held PDA	10	DY	50.00							$500.00	$500.00		$575.00	
	Radios	5	DY	20.00							$100.00	$100.00		$115.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Misc. H&S Equip	5	DY	50.00				$250.00				$250.00		$287.50	
	Excavation Tool Kit	5	DY	50.00							$250.00	$250.00		$287.50	
	Per Diem	49	DY	328.00			$16,072.00					$16,072.00		$18,482.80	

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Aerial Rocket Range Target #1 MRS FS Cost Estimate					HO	Field							Subtotal	Subtotal w/MUP	Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	Straight LABOR $	Straight LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	5% OH & 10% Profit	Effort
0420	**Digital Geophysical Mapping (DGM) (5-10hr dys, per diem @ 7 dys/wk)**												**$19,232.11**		**$26,893.17**
	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	36.29		$1,451.42						$1,451.42		$2,902.85	
	UXO Tech II (OT)	10	HR	54.43		$544.28						$544.28		$1,088.57	
	Computer	5	DY	10.00				$50.00				$50.00		$57.50	
	Internet Service	5	DY	5.00					$25.00			$25.00		$28.75	
	Magnetometer	5	DY	125.00				$625.00				$625.00		$718.75	
	TDEM Detector	5	DY	125.00				$625.00				$625.00		$718.75	
	Positioning	5	DY	225.00				$1,125.00				$1,125.00		$1,293.75	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Radios	5	DY	20.00							$100.00	$100.00		$115.00	
	GPS - RTK	5	DY	225.00							$1,125.00	$1,125.00		$1,293.75	
	Pickup Truck 4x4 w/FOG (2 ea)	14	DY	200.00				$2,800.00				$2,800.00		$3,220.00	
	Per Diem	21	DY	328.00			$6,888.00					$6,888.00		$7,921.20	
0430	**Geophysical Data Analysis (5-10hr dys, per diem @ 7 dys/wk)**												**$14,628.50**		**$22,637.21**
	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		$28.75	
	Computer	5	DY	10.00				$50.00				$50.00		$57.50	
	Internet Service	5	DY	5.00					$25.00			$25.00		$28.75	
	Printer	5	DY	10.00				$50.00				$50.00		$57.50	
	SUV 4x4 w/FOG	5	DY	90.00				$450.00				$450.00		$517.50	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Project Phone Service	5	DY	10.00							$50.00	$50.00		$57.50	
	Per Diem	21	DY	328.00			$6,888.00					$6,888.00		$7,921.20	
0440	**Anomaly Re-Acquisition (5-10hr dys, per diem @ 7 dys/wk)**												**$4,356.43**		**$5,164.11**
	UXO Tech II	5	HR	36.29		$181.43						$181.43		$362.86	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	GPS - RTK	5	DY	225.00							$1,125.00	$1,125.00		$1,293.75	
	USRAD	5	DY	225.00				$1,125.00				$1,125.00		$1,293.75	
	SUV 4x4 w/FOG	5	DY	90.00				$450.00				$450.00		$517.50	
	Per Diem	7	DY	175.00			$1,225.00					$1,225.00		$1,408.75	

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ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	Straight LABOR $	Straight LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	5% OH & 10% Profit	Effort
0450	**MD Subsurface Removal (DGM) (5-10hr dys, per diem @ 7 dys/wk)**												**$35,796.57**		**$53,341.95**
	UXO Tech II (6) (ST)	240	HR	36.29		$8,708.54						$8,708.54		$17,417.09	
	UXO Tech II (6) (OT)	60	HR	54.43		$3,265.70						$3,265.70		$6,531.41	
	UXO Tech III (ST)	40	HR	42.73		$1,709.33						$1,709.33		$3,418.66	
	UXO Tech III (OT)	10	HR	64.10		$641.00						$641.00		$1,282.00	
	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	200.00				$2,800.00				$2,800.00		$3,220.00	
	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		$230.00	
	FOG	100	GL	5.00							$500.00	$500.00		$575.00	
	Schonstedt (6 ea)	30	DY	10.00							$300.00	$300.00		$345.00	
	GPS - Hand Held	5	DY	50.00							$250.00	$250.00		$287.50	
	Hand Held PDA	10	DY	50.00							$500.00	$500.00		$575.00	
	Radios	5	DY	20.00							$100.00	$100.00		$115.00	
	Consumable Supplies	5	DY	50.00							$250.00	$250.00		$287.50	
	Misc. H&S Equip	5	DY	50.00				$250.00				$250.00		$287.50	
	Excavation Tool Kit	5	DY	50.00							$250.00	$250.00		$287.50	
	Per Diem	49	DY	328.00			$16,072.00					$16,072.00		$18,482.80	
0500	**MPPEH BIP (1-10hr dy, per diem @ 7 dys/wk)**												**$7,169.31**		**$10,679.89**
	UXO Tech II (6 ea) (ST)	48	HR	36.29		$1,741.71						$1,741.71		$3,483.42	
	UXO Tech II (6 ea) (OT)	12	HR	54.43		$653.14						$653.14		$1,306.28	
	UXO Tech III (ST)	8	HR	42.73		$341.87						$341.87		$683.73	
	UXO Tech III (OT)	2	HR	64.10		$128.20						$128.20		$256.40	
	Pickup Truck 4x4 w/FOG (2 ea)	3	DY	200.00				$560.00				$560.00		$644.00	
	Gator ATV	1	DY	40.00				$40.00				$40.00		$46.00	
	Hand Held PDA	1	DY	50.00							$70.00	$70.00		$80.50	
	Radios	2	DY	20.00							$40.00	$40.00		$46.00	
	Misc ODCs (picks & shovels)	1	DY	30.00				$30.00				$30.00		$34.50	
	Misc. H&S Equip	1	DY	50.00				$50.00				$50.00		$57.50	
	Donor Explosives	1	DY	100.00							$100.00	$100.00		$115.00	
	Explosives Vehicle	1	DY	200.00				$200.00				$200.00		$230.00	
	Per Diem	10	DY	328.00			$3,214.40					$3,214.40		$3,696.56	
0510	**Scrap Certification & Disposal (1-10hr dy, per diem @ 7 dys/wk @1 ton/day)**												**$3,565.95**		**$5,178.94**
	UXO Tech II (2 ea) (ST)	16	HR	36.29		$580.57						$580.57		$1,161.14	
	UXO Tech II (2 ea) (OT)	4	HR	54.43		$217.71						$217.71		$435.43	
	UXO Tech III (ST)	8	HR	42.73		$341.87						$341.87		$683.73	
	UXO Tech III (OT)	2	HR	64.10		$128.20						$128.20		$256.40	
	Pickup Truck 4x4 w/FOG	1	DY	200.00				$280.00				$280.00		$322.00	
	Gator ATV	1	DY	40.00				$40.00				$40.00		$46.00	
	FOG	10	GL	5.00							$50.00	$50.00		$57.50	
	Radios	1	DY	20.00							$20.00	$20.00		$23.00	
	Misc ODCs (picks & shovels)	1	DY	30.00				$30.00				$30.00		$34.50	
	Recycler - Scrap Disposal	1	DY	500.00				$500.00				$500.00		$575.00	
	Per Diem	4	DY	328.00			$1,377.60					$1,377.60		$1,584.24	

Feasibility Study Cost Estimate-Backup Data
Former Nantucket Ordnance Site
Nantucket, Massachusetts

Aerial Rocket Range Target #1 MRS FS Cost Estimate					HO Straight	Field Straight LABOR							Subtotal	Subtotal w/MUP	Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	LABOR $	$	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	5% OH & 10% Profit	Effort
0600	**Site Restoration (5-10hr dys, per diem @ 7 dys/wk backfill holes from investigation)**												**$16,688.03**		**$22,885.37**
	UXO Tech II/Operator (1 ea) (ST)	40	HR	36.29		$1,451.42						$1,451.42		$2,902.85	
	UXO Tech II/Operator (1 ea) (OT)	10	HR	54.43		$544.28						$544.28		$1,088.57	
	UXO Tech III (ST)	40	HR	42.73		$1,709.33						$1,709.33		$3,418.66	
	UXO Tech III (OT)	10	HR	64.10		$641.00						$641.00		$1,282.00	
	Pickup Truck 4x4 w/FOG (2 ea)	7	DY	200.00				$1,400.00				$1,400.00		$1,610.00	
	Skid Steer	7	DY	450.00							$3,150.00	$3,150.00		$3,622.50	
	FOG	75	GL	5.00							$375.00	$375.00		$431.25	
	Misc Small Tools/Equip	5	DY	40.00				$200.00				$200.00		$230.00	
	Fill Materials	175	CY	15.00							$2,625.00	$2,625.00		$3,018.75	
	Per Diem	14	DY	328.00			$4,592.00					$4,592.00		$5,280.80	
0610	**Demobilization (Demob expenses)**												**$16,250.00**		**$18,687.50**
	Sub: Demob Misc Equipment	5	EA	500.00					$2,500.00			$2,500.00		$2,875.00	
	Misc ODCs	5	DY	50.00							$250.00	$250.00		$287.50	
	Demob Allowance per Person	9	EA	1,500.00							$13,500.00	$13,500.00		$15,525.00	
0700	**Final Report (incl. draft, draft-final, & final)**												**$27,912.21**		**$71,944.12**
	QC Manager(ST)	16		51.08	$817.28							$817.28		$2,451.84	
	Mid Engineer (ST)	75		38.65	$2,898.75							$2,898.75		$8,696.25	
	Regulatory Specialist(ST)	60		44.75	$2,685.00							$2,685.00		$8,055.00	
	Administrative(ST)	50		27.47	$1,373.50							$1,373.50		$4,120.50	
	Associate Geoscientist(ST)	160		30.24	$4,838.40							$4,838.40		$14,515.20	
	CADD/GIS Operator(ST)	60		32.40	$1,944.00							$1,944.00		$5,832.00	
	Project Geophysicist(ST)	100		56.33	$5,633.28							$5,633.28		$16,899.84	
	SUXOS(ST)	30		47.73	$1,432.00							$1,432.00		$4,295.99	
	Outside Reproduction	30	EA	150.00							$4,500.00	$4,500.00		$5,175.00	
	Shipping	30	EA	25.00							$750.00	$750.00		$862.50	
	ACAD Recovery	80	HR	13.00						$1,040.00		$1,040.00		$1,040.00	
0800	**Land Use Controls**												**$27,000.00**		**$31,050.00**
	Containment and Controls Plan	1	LS	5,000.00					$5,000.00			$5,000.00		$5,750.00	
	Maintain Signs	6	EA	500.00					$3,000.00			$3,000.00		$3,450.00	
	Letters/Brochure/Fact Sheet	1	LS	5,000.00					$5,000.00			$5,000.00		$5,750.00	
	Prepare & Distribute DVDs	1	LS	10,000.00					$10,000.00			$10,000.00		$11,500.00	
	Update Websites	1	LS	2,500.00					$2,500.00			$2,500.00		$2,875.00	
	RAB (per mtg)	1	LS	1,500.00					$1,500.00			$1,500.00		$1,725.00	
0900	**Long Term Management - Periodic Costs**												**$11,250.00**		**$12,937.50**
	Letters/Brochure/Fact Sheet	1	LS	5,000.00					$5,000.00			$5,000.00		$5,750.00	
	Distribute DVDs	1	LS	5,000.00					$5,000.00			$5,000.00		$5,750.00	
	Update Websites	1	LS	1,250.00					$1,250.00			$1,250.00		$1,437.50	
0910	**Long Term Management - Annual Costs**												**$9,500.00**		**$10,925.00**
	Maintain Signs	6	EA	500.00					$3,000.00			$3,000.00		$3,450.00	
	RAB (per mtg)	1	LS	1,500.00					$1,500.00			$1,500.00		$1,725.00	
	Annual Inspection	1	LS	5,000.00					$5,000.00			$5,000.00		$5,750.00	
0920	**On-Call UXO Support - Annual Cost**												**$13,071.47**		**$20,271.13**
	UXO Tech II (ST)	72	HR	36.29		$2,612.56						$2,612.56		$5,225.13	
	UXO Tech II (OT)	4	HR	54.43		$217.71						$217.71		$435.43	
	UXO Tech III (ST)	72	HR	42.73		$3,076.79						$3,076.79		$6,153.58	

Feasibility Study Cost Estimate-Backup Data
Former Nantucket Ordnance Site
Nantucket, Massachusetts

Aerial Rocket Range Target #1 MRS FS Cost Estimate					HO	Field							Subtotal	Subtotal w/MUP	Total
ACT ID	WORK DESCRIPTION	qty	unit	Raw $ per	Straight LABOR $	Straight LABOR $	TRAVEL	EQUIP	SUBS	INTS	EXTS	SUBTOTAL COST	Raw	5% OH & 10% Profit	Effort
	UXO Tech III (OT)	4	HR	64.10		$256.40						$256.40		$512.80	
	Pickup Truck 4x4 w/FOG (2 ea)	6	DY	100.00				$600.00				$600.00		$690.00	
	Hand Held PDA	6	DY	50.00							$300.00	$300.00		$345.00	
	Radios	12	DY	20.00							$240.00	$240.00		$276.00	
	Misc ODCs (picks & shovels)	6	DY	30.00				$180.00				$180.00		$207.00	
	Misc. H&S Equip	6	DY	50.00				$300.00				$300.00		$345.00	
	Donor Explosives	2	EA	1,000.00							$2,000.00	$2,000.00		$2,300.00	
	Explosives Vehicle	6	DY	100.00				$600.00				$600.00		$690.00	
	Ferry	4	EA	150.00							$600.00	$600.00		$690.00	
	Parking	12	DY	10.00			$120.00					$120.00		$138.00	
	Per Diem	6	DY	328.00			$1,968.00					$1,968.00		$2,263.20	
1000	**5Y Review - Periodic Cost**												**$31,500.00**		**$36,225.00**
	Recurring Review Plan	1	LS	3,000.00					$3,000.00			$3,000.00		$3,450.00	
	Document Reviews	1	EA	1,000.00					$1,000.00			$1,000.00		$1,150.00	
	Site Analysis and Work Plan	1	LS	10,000.00					$10,000.00			$10,000.00		$11,500.00	
	Design Center Review	1	EA	5,000.00					$5,000.00			$5,000.00		$5,750.00	
	Site Inspection	1	EA	7,500.00					$7,500.00			$7,500.00		$8,625.00	
	Report	1	LS	5,000.00					$5,000.00			$5,000.00		$5,750.00	
1010	**5Y Reviews (Yr 10-30) - Periodic Costs**												**$17,500.00**		**$20,125.00**
	Document Reviews	1	EA	1,000.00					$1,000.00			$1,000.00		$1,150.00	
	Design Center Review	1	EA	4,000.00					$4,000.00			$4,000.00		$4,600.00	
	Site Inspection	1	EA	7,500.00					$7,500.00			$7,500.00		$8,625.00	
	Report	1	EA	5,000.00					$5,000.00			$5,000.00		$5,750.00	

Nantucket FUDS
FS-Cost Data Source Information

Labor Category	ST Rate	OT Rate	Description
QC Manager	$ 51.08	$ 76.62	Prime rates 2014
Mid Engineer	$ 38.65	$ 57.98	Prime rates 2014
Regulatory Specialist	$ 44.75	$ 67.13	Prime rates 2014
Administrative Assistant	$ 27.47	$ 41.21	Prime rates 2014
Associate Geoscientist	$ 30.24	$ 45.36	Prime rates 2014
CADD/GIS Operator	$ 32.40	$ 48.60	Prime rates 2014
Geophysical Technician	$ 30.24	$ 45.36	Prime rates 2014
Site Geophysicist	$ 35.64	$ 53.46	Prime rates 2014
Heavy Equipment Operator	$ 29.28	$ 43.91	Prime rates 2014
Site Manager	$ 37.80	$ 56.70	Prime rates 2014
Project Geophysicist	$ 56.33	$ 84.50	Prime rates 2014
UXOSO/QCS	$ 43.73	$ 65.60	Decision No. 2005-2260 (rev 15) 6/19/2013+H&W+Holiday+4% Haz+UXOSO/QCS Differential
UXO Tech II	$ 36.29	$ 54.43	Decision No. 2005-2260 (rev 15) 6/19/2013+H&W+Holiday+4% Haz
UXO Tech III	$ 42.73	$ 64.10	Decision No. 2005-2260 (rev 15) 6/19/2013+H&W+Holiday+4% Haz
SUXOS	$ 47.73	$ 71.60	Decision No. 2005-2260 (rev 15) 6/19/2013+H&W+Holiday+4% Haz+SUXO Differential

MD Items expected to be found
5-inch HVAR's
3.5-inch FFARs
2.25-inch SCARs
Miscellaneous rocket components
frag

Item	Unit	Unit Rate	Source of Data
Outside Reproduction	EA	$150	Town and Country Reprographics
Shipping	EA	$25	Fedex
ACAD Recovery	HR	$13	Federal recovery rate
Sub: Mob Misc Equipment	EA	$500	Historical costs
Misc ODCs	DY	$100	Estimated-Rough Order Magnitude
Equip & Supplies	LS	$1,000	Estimated-Rough Order Magnitude
Pickup Truck 4x4 w/FOG	DY	$200	Hertz
Per Diem	DY	$328	GSA FY 2014 ($267 lodging and $61 meals or $328 peak season)
/Demob Allowance per Person	EA	$1,500	Estimated-Rough Order Magnitude
Computer	DY	$10	Estimated-Rough Order Magnitude
Copier/Fax	DY	$5	Estimated-Rough Order Magnitude
Printer	DY	$10	Estimated-Rough Order Magnitude
Internet Service	DY	$5	Estimated-Rough Order Magnitude
Generator w/FOG	DY	$40	Champion Rentals
Port-a-John	DY	$10	Huges Septic
Storm Detector	DY	$80	CES
Schonstedt	DY	$30	CES
Storage Box (CONEX)	DY	$15	Sun Island Stores
Consumable Supplies	DY	$50	Estimated-Rough Order Magnitude
Mechanics Tool Kit	DY	$5	Estimated-Rough Order Magnitude
Demolition Tool Kit	LS	$20	Estimated-Rough Order Magnitude
Radios	DY	$20	Bearcom
Brush Cutter, Power	DY	$15	Toscana
Chain Saw	DY	$15	CES
Gator ATV	DY	$40	Hertz
Ferry	EA	$150	Hyline Cruise

Item	Unit	Unit Rate	Source of Data
GPS - Hand Held	DY	$50	CES
Hand Held PDA (2)	DY	$50	CES
Universal Loader/Backhoe w/FOG	DY	$60	Champion Rentals
Trailer Flat Bed	DY	$15	Bamber Trucking
Misc ODCs (picks & shovels)	DY	$30	CES
Misc. H&S Equip	DY	$50	Estimated-Rough Order Magnitude
Donor Explosives	DY	$1,000	Jet Research
Explosives Vehicle	DY	$200	Estimated
Recycler - Scrap Disposal	DY	$500	
Skid Steer	DY	$450	Toscana
Misc Small Tools/Equip	DY	$40	Estimated-Rough Order Magnitude
Fill Materials	CY	$15	Toscana
Containment and Controls Plan	LS	$5,000	Estimated-Rough Order Magnitude
Maintain Signs	EA	$500	Estimated-Rough Order Magnitude
Brochure/Fact Sheet	LS	$5,000	Estimated-Rough Order Magnitude
Prepare & Distribute DVDs	LS	$10,000	Estimated-Rough Order Magnitude
Update Websites	LS	$1,250	Estimated-Rough Order Magnitude
TRC (per mtg)	LS	$1,500	Estimated-Rough Order Magnitude
Recurring Review Plan	LS	$3,000	Estimated-Rough Order Magnitude
Document Reviews	EA	$1,000	Estimated-Rough Order Magnitude
Site Analysis and Work Plan	LS	$10,000	Estimated-Rough Order Magnitude
Design Center Review	EA	$5,000	Estimated-Rough Order Magnitude
Site Inspection	EA	$7,500	Estimated-Rough Order Magnitude
Report	LS	$5,000	Estimated-Rough Order Magnitude
Parking	EA	$10	Hyline Cruise Lot Fee

Item	Unit	Rate	Source of Data
Overhead	%	10	EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS, July 200
Profit	%	5	EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS, July 200
Discount Factor	%	7	EPA 540-R-00-002 OSWER 9355.0-75 A Guide to Developing and Documenting Cost Estimates During FS, July 200

Section J - List of Documents, Exhibits and Other Attachments

WAGE DETERMINATION

WAGE DETERMINATION DECISION
OF THE SECRETARY OF LABOR

The following wage determination will be used to conform
with the requirements of the Service Contract Act of 1965
(29 CFR 4) of the General Provisions:

Decision No. 05-2259(rev.11) dated: 06/15/2010

WD 05-2259 (Rev.-11) was first posted on www.wdol.gov on 06/22/2010

REGISTER OF WAGE DETERMINATIONS UNDER THE SERVICE CONTRACT ACT
By direction of the Secretary of Labor

Shirley F. Ebbesen
Director

Division of
Wage Determinations

U.S. DEPARTMENT OF LABOR
EMPLOYMENT STANDARDS ADMINISTRATION
WAGE AND HOUR DIVISION
WASHINGTON D.C. 20210

Wage Determination No.: 2005-2259
Revision No.: 11
Date Of Revision: 06/15/2010

This wage determination applies to the following counties in MASSACHUSETTS:
BARNSTABLE, BRISTOL, DUKES, NANTUCKET, NORFOLK, and PLYMOUTH Excluding the
cities and towns listed below:

BRISTOL County: Attleboro City, Mansfield, North Attleborough Town, Norton
Town, Raynham, Reheoboth Town, and Seekonk.

NORFOLK County: Quincy City, Bellingham Town, Braintree Town, Brookline Town,
Canton Town, Cohasset Town, Dedham Town, Dover Town, Foxborough Town, Franklin
Town, Holbrook Town, Medfield Town, Medway Town, Millis Town, Milton Town,
Needham Town, Norfolk Town, Norwood Town, Randolph Town, Sharon Town,
Stoughton Town, Walpole Town, Wellesley Town, Westwood Town, Weymouth Town,
and Wrentham Town.

PLYMOUTH County: Carver, Duxbury Town, Hanover Town, Hanson Town, Hingham Town,
Hull Town, Kingston Town, Lakeville, Marshfield Town, Middleborough, Norwell
Town, Pembroke Town, Plymouth, Plympton, Rockland Town, and Scituate Town.

Fringe Benefits Required Follow the Occupational Listing

OCCUPATION CODE - TITLE	FOOTNOTE	RATE
01000 - Administrative Support And Clerical Occupations		
01011 - Accounting Clerk I		15.23
01012 - Accounting Clerk II		17.10
01013 - Accounting Clerk III		19.14
01020 - Administrative Assistant		25.42
01040 - Court Reporter		20.86
01051 - Data Entry Operator I		15.64
01052 - Data Entry Operator II		16.79
01060 - Dispatcher, Motor Vehicle		19.79
01070 - Document Preparation Clerk		14.87
01090 - Duplicating Machine Operator		14.87
01111 - General Clerk I		14.66
01112 - General Clerk II		16.00
01113 - General Clerk III		18.17
01120 - Housing Referral Assistant		23.44
01141 - Messenger Courier		12.98
01191 - Order Clerk I		15.91
01192 - Order Clerk II		17.36
01261 - Personnel Assistant (Employment) I		17.41
01262 - Personnel Assistant (Employment) II		19.48
01263 - Personnel Assistant (Employment) III		21.71
01270 - Production Control Clerk		22.65
01280 - Receptionist		14.31
01290 - Rental Clerk		17.19

01300 - Scheduler, Maintenance	18.80
01311 - Secretary I	18.80
01312 - Secretary II	21.03
01313 - Secretary III	23.44
01320 - Service Order Dispatcher	17.49
01410 - Supply Technician	25.42
01420 - Survey Worker	15.77
01531 - Travel Clerk I	13.79
01532 - Travel Clerk II	14.92
01533 - Travel Clerk III	16.08
01611 - Word Processor I	16.11
01612 - Word Processor II	18.08
01613 - Word Processor III	20.22
05000 - Automotive Service Occupations	
05005 - Automobile Body Repairer, Fiberglass	24.65
05010 - Automotive Electrician	21.99
05040 - Automotive Glass Installer	21.02
05070 - Automotive Worker	21.02
05110 - Mobile Equipment Servicer	19.02
05130 - Motor Equipment Metal Mechanic	22.95
05160 - Motor Equipment Metal Worker	21.02
05190 - Motor Vehicle Mechanic	22.95
05220 - Motor Vehicle Mechanic Helper	17.94
05250 - Motor Vehicle Upholstery Worker	19.98
05280 - Motor Vehicle Wrecker	21.02
05310 - Painter, Automotive	21.99
05340 - Radiator Repair Specialist	21.02
05370 - Tire Repairer	13.39
05400 - Transmission Repair Specialist	22.95
07000 - Food Preparation And Service Occupations	
07010 - Baker	14.00
07041 - Cook I	12.55
07042 - Cook II	13.85
07070 - Dishwasher	9.74
07130 - Food Service Worker	12.03
07210 - Meat Cutter	20.00
07260 - Waiter/Waitress	12.62
09000 - Furniture Maintenance And Repair Occupations	
09010 - Electrostatic Spray Painter	16.33
09040 - Furniture Handler	11.81
09080 - Furniture Refinisher	17.25
09090 - Furniture Refinisher Helper	13.94
09110 - Furniture Repairer, Minor	15.68
09130 - Upholsterer	17.64
11000 - General Services And Support Occupations	
11030 - Cleaner, Vehicles	11.66
11060 - Elevator Operator	11.66
11090 - Gardener	18.44
11122 - Housekeeping Aide	14.28
11150 - Janitor	14.28
11210 - Laborer, Grounds Maintenance	15.13
11240 - Maid or Houseman	11.58
11260 - Pruner	13.72
11270 - Tractor Operator	17.31
11330 - Trail Maintenance Worker	15.13
11360 - Window Cleaner	15.75
12000 - Health Occupations	
12010 - Ambulance Driver	18.55
12011 - Breath Alcohol Technician	18.55
12012 - Certified Occupational Therapist Assistant	22.30
12015 - Certified Physical Therapist Assistant	22.60
12020 - Dental Assistant	18.96
12025 - Dental Hygienist	37.80
12030 - EKG Technician	28.17
12035 - Electroneurodiagnostic Technologist	28.17
12040 - Emergency Medical Technician	18.55
12071 - Licensed Practical Nurse I	18.83
12072 - Licensed Practical Nurse II	21.06
12073 - Licensed Practical Nurse III	23.48
12100 - Medical Assistant	16.90
12130 - Medical Laboratory Technician	19.41
12160 - Medical Record Clerk	15.94
12190 - Medical Record Technician	17.83
12195 - Medical Transcriptionist	18.12

12210 - Nuclear Medicine Technologist		35.16
12221 - Nursing Assistant I		11.45
12222 - Nursing Assistant II		12.87
12223 - Nursing Assistant III		13.65
12224 - Nursing Assistant IV		15.90
12235 - Optical Dispenser		22.55
12236 - Optical Technician		19.18
12250 - Pharmacy Technician		20.80
12280 - Phlebotomist		15.92
12305 - Radiologic Technologist		32.92
12311 - Registered Nurse I		31.18
12312 - Registered Nurse II		40.19
12313 - Registered Nurse II, Specialist		40.19
12314 - Registered Nurse III		48.63
12315 - Registered Nurse III, Anesthetist		48.63
12316 - Registered Nurse IV		58.29
12317 - Scheduler (Drug and Alcohol Testing)		20.62
13000 - Information And Arts Occupations		
13011 - Exhibits Specialist I		22.17
13012 - Exhibits Specialist II		27.46
13013 - Exhibits Specialist III		33.59
13041 - Illustrator I		21.90
13042 - Illustrator II		27.12
13043 - Illustrator III		33.18
13047 - Librarian		34.75
13050 - Library Aide/Clerk		15.72
13054 - Library Information Technology Systems Administrator		28.03
13058 - Library Technician		18.69
13061 - Media Specialist I		16.60
13062 - Media Specialist II		18.13
13063 - Media Specialist III		20.22
13071 - Photographer I		17.70
13072 - Photographer II		19.80
13073 - Photographer III		24.53
13074 - Photographer IV		30.00
13075 - Photographer V		36.30
13110 - Video Teleconference Technician		19.27
14000 - Information Technology Occupations		
14041 - Computer Operator I		19.71
14042 - Computer Operator II		22.05
14043 - Computer Operator III		24.58
14044 - Computer Operator IV		27.32
14045 - Computer Operator V		30.25
14071 - Computer Programmer I	(see 1)	24.68
14072 - Computer Programmer II	(see 1)	
14073 - Computer Programmer III	(see 1)	
14074 - Computer Programmer IV	(see 1)	
14101 - Computer Systems Analyst I	(see 1)	
14102 - Computer Systems Analyst II	(see 1)	
14103 - Computer Systems Analyst III	(see 1)	
14150 - Peripheral Equipment Operator		19.71
14160 - Personal Computer Support Technician		27.32
15000 - Instructional Occupations		
15010 - Aircrew Training Devices Instructor (Non-Rated)		35.72
15020 - Aircrew Training Devices Instructor (Rated)		43.22
15030 - Air Crew Training Devices Instructor (Pilot)		48.81
15050 - Computer Based Training Specialist / Instructor		35.72
15060 - Educational Technologist		32.16
15070 - Flight Instructor (Pilot)		48.81
15080 - Graphic Artist		31.54
15090 - Technical Instructor		25.37
15095 - Technical Instructor/Course Developer		31.02
15110 - Test Proctor		20.47
15120 - Tutor		20.47
16000 - Laundry, Dry-Cleaning, Pressing And Related Occupations		
16010 - Assembler		10.71
16030 - Counter Attendant		10.71
16040 - Dry Cleaner		14.24
16070 - Finisher, Flatwork, Machine		10.71
16090 - Presser, Hand		10.71
16110 - Presser, Machine, Drycleaning		10.71
16130 - Presser, Machine, Shirts		10.71
16160 - Presser, Machine, Wearing Apparel, Laundry		10.71

16190 - Sewing Machine Operator 15.10
16220 - Tailor 15.78
16250 - Washer, Machine 11.92
19000 - Machine Tool Operation And Repair Occupations
19010 - Machine-Tool Operator (Tool Room) 22.72
19040 - Tool And Die Maker 26.82
21000 - Materials Handling And Packing Occupations
21020 - Forklift Operator 17.64
21030 - Material Coordinator 22.65
21040 - Material Expediter 22.65
21050 - Material Handling Laborer 14.26
21071 - Order Filler 15.03
21080 - Production Line Worker (Food Processing) 17.64
21110 - Shipping Packer 18.63
21130 - Shipping/Receiving Clerk 18.63
21140 - Store Worker I 12.66
21150 - Stock Clerk 17.11
21210 - Tools And Parts Attendant 17.64
21410 - Warehouse Specialist 17.64
23000 - Mechanics And Maintenance And Repair Occupations
23010 - Aerospace Structural Welder 30.32
23021 - Aircraft Mechanic I 28.22
23022 - Aircraft Mechanic II 30.32
23023 - Aircraft Mechanic III 30.61
23040 - Aircraft Mechanic Helper 20.65
23050 - Aircraft, Painter 24.38
23060 - Aircraft Servicer 23.22
23080 - Aircraft Worker 24.04
23110 - Appliance Mechanic 24.24
23120 - Bicycle Repairer 14.12
23125 - Cable Splicer 30.77
23130 - Carpenter, Maintenance 28.56
23140 - Carpet Layer 26.29
23160 - Electrician, Maintenance 32.18
23181 - Electronics Technician Maintenance I 26.39
23182 - Electronics Technician Maintenance II 27.59
23183 - Electronics Technician Maintenance III 28.80
23260 - Fabric Worker 22.03
23290 - Fire Alarm System Mechanic 24.63
23310 - Fire Extinguisher Repairer 21.01
23311 - Fuel Distribution System Mechanic 25.71
23312 - Fuel Distribution System Operator 20.37
23370 - General Maintenance Worker 23.18
23380 - Ground Support Equipment Mechanic 28.22
23381 - Ground Support Equipment Servicer 23.22
23382 - Ground Support Equipment Worker 24.04
23391 - Gunsmith I 21.01
23392 - Gunsmith II 23.18
23393 - Gunsmith III 25.30
23410 - Heating, Ventilation And Air-Conditioning Mechanic 24.66
23411 - Heating, Ventilation And Air Contditioning Mechanic (Research Facility) 26.02
23430 - Heavy Equipment Mechanic 24.63
23440 - Heavy Equipment Operator 28.89
23460 - Instrument Mechanic 24.45
23465 - Laboratory/Shelter Mechanic 24.24
23470 - Laborer 15.05
23510 - Locksmith 24.24
23530 - Machinery Maintenance Mechanic 25.30
23550 - Machinist, Maintenance 25.30
23580 - Maintenance Trades Helper 19.59
23591 - Metrology Technician I 25.45
23592 - Metrology Technician II 26.51
23593 - Metrology Technician III 27.61
23640 - Millwright 25.78
23710 - Office Appliance Repairer 24.24
23760 - Painter, Maintenance 24.24
23790 - Pipefitter, Maintenance 28.03
23810 - Plumber, Maintenance 26.86
23820 - Pneudraulic Systems Mechanic 25.30
23850 - Rigger 25.30
23870 - Scale Mechanic 23.18
23890 - Sheet-Metal Worker, Maintenance 25.56

23910 - Small Engine Mechanic	23.18
23931 - Telecommunications Mechanic I	27.79
23932 - Telecommunications Mechanic II	29.70
23950 - Telephone Lineman	28.74
23960 - Welder, Combination, Maintenance	25.30
23965 - Well Driller	25.30
23970 - Woodcraft Worker	25.30
23980 - Woodworker	21.01
24000 - Personal Needs Occupations	
24570 - Child Care Attendant	14.11
24580 - Child Care Center Clerk	17.60
24610 - Chore Aide	11.77
24620 - Family Readiness And Support Services Coordinator	15.78
24630 - Homemaker	19.55
25000 - Plant And System Operations Occupations	
25010 - Boiler Tender	24.78
25040 - Sewage Plant Operator	22.18
25070 - Stationary Engineer	24.78
25190 - Ventilation Equipment Tender	19.18
25210 - Water Treatment Plant Operator	22.18
27000 - Protective Service Occupations	
27004 - Alarm Monitor	19.31
27007 - Baggage Inspector	15.85
27008 - Corrections Officer	26.87
27010 - Court Security Officer	25.91
27030 - Detection Dog Handler	18.95
27040 - Detention Officer	26.87
27070 - Firefighter	23.93
27101 - Guard I	15.85
27102 - Guard II	18.95
27131 - Police Officer I	26.92
27132 - Police Officer II	29.74
28000 - Recreation Occupations	
28041 - Carnival Equipment Operator	13.20
28042 - Carnival Equipment Repairer	13.98
28043 - Carnival Equpment Worker	10.92
28210 - Gate Attendant/Gate Tender	16.24
28310 - Lifeguard	13.01
28350 - Park Attendant (Aide)	17.74
28510 - Recreation Aide/Health Facility Attendant	13.58
28515 - Recreation Specialist	22.62
28630 - Sports Official	14.47
28690 - Swimming Pool Operator	19.44
29000 - Stevedoring/Longshoremen Occupational Services	
29010 - Blocker And Bracer	23.66
29020 - Hatch Tender	23.66
29030 - Line Handler	23.66
29041 - Stevedore I	21.96
29042 - Stevedore II	24.16
30000 - Technical Occupations	
30010 - Air Traffic Control Specialist, Center (HFO) (see 2)	39.10
30011 - Air Traffic Control Specialist, Station (HFO) (see 2)	27.25
30012 - Air Traffic Control Specialist, Terminal (HFO) (see 2)	29.69
30021 - Archeological Technician I	21.07
30022 - Archeological Technician II	23.57
30023 - Archeological Technician III	29.20
30030 - Cartographic Technician	29.20
30040 - Civil Engineering Technician	26.54
30061 - Drafter/CAD Operator I	21.07
30062 - Drafter/CAD Operator II	23.57
30063 - Drafter/CAD Operator III	26.27
30064 - Drafter/CAD Operator IV	32.34
30081 - Engineering Technician I	17.29
30082 - Engineering Technician II	19.42
30083 - Engineering Technician III	21.74
30084 - Engineering Technician IV	26.93
30085 - Engineering Technician V	32.93
30086 - Engineering Technician VI	39.07
30090 - Environmental Technician	26.74
30210 - Laboratory Technician	23.40
30240 - Mathematical Technician	29.20
30361 - Paralegal/Legal Assistant I	20.13
30362 - Paralegal/Legal Assistant II	25.32

30363 - Paralegal/Legal Assistant III		30.97
30364 - Paralegal/Legal Assistant IV		37.46
30390 - Photo-Optics Technician		29.20
30461 - Technical Writer I		26.44
30462 - Technical Writer II		32.34
30463 - Technical Writer III		39.13
30491 - Unexploded Ordnance (UXO) Technician I		24.85
30492 - Unexploded Ordnance (UXO) Technician II		30.07
30493 - Unexploded Ordnance (UXO) Technician III		36.04
30494 - Unexploded (UXO) Safety Escort		24.85
30495 - Unexploded (UXO) Sweep Personnel		24.85
30620 - Weather Observer, Combined Upper Air Or Surface Programs	(see 2)	26.27
30621 - Weather Observer, Senior	(see 2)	29.20
31000 - Transportation/Mobile Equipment Operation Occupations		
31020 - Bus Aide		13.20
31030 - Bus Driver		17.52
31043 - Driver Courier		15.79
31260 - Parking and Lot Attendant		10.84
31290 - Shuttle Bus Driver		16.93
31310 - Taxi Driver		12.95
31361 - Truckdriver, Light		16.93
31362 - Truckdriver, Medium		18.70
31363 - Truckdriver, Heavy		20.68
31364 - Truckdriver, Tractor-Trailer		20.68
99000 - Miscellaneous Occupations		
99030 - Cashier		9.32
99050 - Desk Clerk		12.56
99095 - Embalmer		26.39
99251 - Laboratory Animal Caretaker I		14.60
99252 - Laboratory Animal Caretaker II		15.66
99310 - Mortician		36.23
99410 - Pest Controller		16.87
99510 - Photofinishing Worker		14.38
99710 - Recycling Laborer		19.74
99711 - Recycling Specialist		23.30
99730 - Refuse Collector		17.90
99810 - Sales Clerk		13.61
99820 - School Crossing Guard		13.77
99830 - Survey Party Chief		24.28
99831 - Surveying Aide		17.27
99832 - Surveying Technician		22.08
99840 - Vending Machine Attendant		15.59
99841 - Vending Machine Repairer		18.68
99842 - Vending Machine Repairer Helper		15.79

ALL OCCUPATIONS LISTED ABOVE RECEIVE THE FOLLOWING BENEFITS:

HEALTH & WELFARE: $3.50 per hour or $140.00 per week or $606.67 per month

VACATION: 2 weeks paid vacation after 1 year of service with a contractor or successor; 3 weeks after 5 years, and 4 weeks after 15 years. Length of service includes the whole span of continuous service with the present contractor or successor, wherever employed, and with the predecessor contractors in the performance of similar work at the same Federal facility. (Reg. 29 CFR 4.173)

HOLIDAYS: A minimum of ten paid holidays per year, New Year's Day, Martin Luther King Jr's Birthday, Washington's Birthday, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans' Day, Thanksgiving Day, and Christmas Day. (A contractor may substitute for any of the named holidays another day off with pay in accordance with a plan communicated to the employees involved.) (See 29 CFR 4174)

THE OCCUPATIONS WHICH HAVE NUMBERED FOOTNOTES IN PARENTHESES RECEIVE THE FOLLOWING:

1) COMPUTER EMPLOYEES: Under the SCA at section 8(b), this wage determination does not apply to any employee who individually qualifies as a bona fide executive, administrative, or professional employee as defined in 29 C.F.R. Part 541. Because

most Computer System Analysts and Computer Programmers who are compensated at a rate not less than $27.63 (or on a salary or fee basis at a rate not less than $455 per week) an hour would likely qualify as exempt computer professionals, (29 C.F.R. 541. 400) wage rates may not be listed on this wage determination for all occupations within those job families. In addition, because this wage determination may not list a wage rate for some or all occupations within those job families if the survey data indicates that the prevailing wage rate for the occupation equals or exceeds $27.63 per hour conformances may be necessary for certain nonexempt employees. For example, if an individual employee is nonexempt but nevertheless performs duties within the scope of one of the Computer Systems Analyst or Computer Programmer occupations for which this wage determination does not specify an SCA wage rate, then the wage rate for that employee must be conformed in accordance with the conformance procedures described in the conformance note included on this wage determination.

Additionally, because job titles vary widely and change quickly in the computer industry, job titles are not determinative of the application of the computer professional exemption. Therefore, the exemption applies only to computer employees who satisfy the compensation requirements and whose primary duty consists of:
(1) The application of systems analysis techniques and procedures, including consulting with users, to determine hardware, software or system functional specifications;
(2) The design, development, documentation, analysis, creation, testing or modification of computer systems or programs, including prototypes, based on and related to user or system design specifications;
(3) The design, documentation, testing, creation or modification of computer programs related to machine operating systems; or
(4) A combination of the aforementioned duties, the performance of which requires the same level of skills. (29 C.F.R. 541.400).

2) AIR TRAFFIC CONTROLLERS AND WEATHER OBSERVERS - NIGHT PAY & SUNDAY PAY: If you work at night as part of a regular tour of duty, you will earn a night differential and receive an additional 10% of basic pay for any hours worked between 6pm and 6am. If you are a full-time employed (40 hours a week) and Sunday is part of your regularly scheduled workweek, you are paid at your rate of basic pay plus a Sunday premium of 25% of your basic rate for each hour of Sunday work which is not overtime (i.e. occasional work on Sunday outside the normal tour of duty is considered overtime work).

HAZARDOUS PAY DIFFERENTIAL: An 8 percent differential is applicable to employees employed in a position that represents a high degree of hazard when working with or in close proximity to ordinance, explosives, and incendiary materials. This includes work such as screening, blending, dying, mixing, and pressing of sensitive ordance, explosives, and pyrotechnic compositions such as lead azide, black powder and photoflash powder. All dry-house activities involving propellants or explosives. Demilitarization, modification, renovation, demolition, and maintenance operations on sensitive ordnance, explosives and incendiary materials. All operations involving regrading and cleaning of artillery ranges.

A 4 percent differential is applicable to employees employed in a position that represents a low degree of hazard when working with, or in close proximity to ordance, (or employees possibly adjacent to) explosives and incendiary materials which involves potential injury such as laceration of hands, face, or arms of the employee engaged in the operation, irritation of the skin, minor burns and the like; minimal damage to immediate or adjacent work area or equipment being used. All operations involving, unloading, storage, and hauling of ordance, explosive, and incendiary ordnance material other than small arms ammunition. These differentials are only applicable to work that has been specifically designated by the agency for ordance, explosives, and incendiary material differential pay.

** UNIFORM ALLOWANCE **

If employees are required to wear uniforms in the performance of this contract (either by the terms of the Government contract, by the employer, by the state or local law, etc.), the cost of furnishing such uniforms and maintaining (by laundering or dry cleaning) such uniforms is an expense that may not be borne by an employee where such cost reduces the hourly rate below that required by the wage determination. The Department of Labor will accept payment in accordance with the following standards as compliance:

The contractor or subcontractor is required to furnish all employees with an adequate number of uniforms without cost or to reimburse employees for the actual cost of the uniforms. In addition, where uniform cleaning and maintenance is made

the responsibility of the employee, all contractors and subcontractors subject to this wage determination shall (in the absence of a bona fide collective bargaining agreement providing for a different amount, or the furnishing of contrary affirmative proof as to the actual cost), reimburse all employees for such cleaning and maintenance at a rate of $3.35 per week (or $.67 cents per day). However, in those instances where the uniforms furnished are made of "wash and wear" materials, may be routinely washed and dried with other personal garments, and do not require any special treatment such as dry cleaning, daily washing, or commercial laundering in order to meet the cleanliness or appearance standards set by the terms of the Government contract, by the contractor, by law, or by the nature of the work, there is no requirement that employees be reimbursed for uniform maintenance costs.

The duties of employees under job titles listed are those described in the "Service Contract Act Directory of Occupations", Fifth Edition, April 2006, unless otherwise indicated. Copies of the Directory are available on the Internet. A links to the Directory may be found on the WHD home page at http://www.dol.gov/esa/whd/ or through the Wage Determinations On-Line (WDOL) Web site at http://wdol.gov/.

REQUEST FOR AUTHORIZATION OF ADDITIONAL CLASSIFICATION AND WAGE RATE {Standard Form 1444 (SF 1444)}

Conformance Process:

The contracting officer shall require that any class of service employee which is not listed herein and which is to be employed under the contract (i.e., the work to be performed is not performed by any classification listed in the wage determination), be classified by the contractor so as to provide a reasonable relationship (i.e., appropriate level of skill comparison) between such unlisted classifications and the classifications listed in the wage determination. Such conformed classes of employees shall be paid the monetary wages and furnished the fringe benefits as are determined. Such conforming process shall be initiated by the contractor prior to the performance of contract work by such unlisted class(es) of employees. The conformed classification, wage rate, and/or fringe benefits shall be retroactive to the commencement date of the contract. {See Section 4.6 (C)(vi)} When multiple wage determinations are included in a contract, a separate SF 1444 should be prepared for each wage determination to which a class(es) is to be conformed.

The process for preparing a conformance request is as follows:

1) When preparing the bid, the contractor identifies the need for a conformed occupation(s) and computes a proposed rate(s).

2) After contract award, the contractor prepares a written report listing in order proposed classification title(s), a Federal grade equivalency (FGE) for each proposed classification(s), job description(s), and rationale for proposed wage rate(s), including information regarding the agreement or disagreement of the authorized representative of the employees involved, or where there is no authorized representative, the employees themselves. This report should be submitted to the contracting officer no later than 30 days after such unlisted class(es) of employees performs any contract work.

3) The contracting officer reviews the proposed action and promptly submits a report of the action, together with the agency's recommendations and pertinent information including the position of the contractor and the employees, to the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, for review. (See section 4.6(b)(2) of Regulations 29 CFR Part 4).

4) Within 30 days of receipt, the Wage and Hour Division approves, modifies, or disapproves the action via transmittal to the agency contracting officer, or notifies the contracting officer that additional time will be required to process the request.

5) The contracting officer transmits the Wage and Hour decision to the contractor.

6) The contractor informs the affected employees.

Information required by the Regulations must be submitted on SF 1444 or bond paper.

When preparing a conformance request, the "Service Contract Act Directory of Occupations" (the Directory) should be used to compare job definitions to insure that duties requested are not performed by a classification already listed in the wage determination. Remember, it is not the job title, but the required tasks that

determine whether a class is included in an established wage determination. Conformances may not be used to artificially split, combine, or subdivide classifications listed in the wage determination.