June 2015

FINAL

FEASIBILITY STUDY

TISBURY GREAT POND MUNITIONS RESPONSE AREA
MARTHA'S VINEYARD, MASSACHUSETTS

FUDS Property No. D01MA0453
Contract No. W912DY-04-D-0019
Task Order No. 0006

U. S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT

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6/11/15

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ACRONYMS

3Rs	recognize, retreat and report
AirMag	airborne magnetometry
Alion	Alion Science and Technology
ARAR	applicable or relevant and appropriate requirements
ASR	Archives Search Report
bgs	below ground surface
BIP	blow-in-place
CERCLA	Comprehensive Environment Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CSM	conceptual site model
DD	Decision Document
DERP	Defense Environmental Restoration Program
DGM	Digital Geophysical Mapping
DGPS	differential global positioning system
DMM	discarded military munitions
DNT	dinitrotoluene
DoD	United States Department of Defense
EM	electromagnetic
EMI	electromagnetic induction
EOD	Explosive Ordnance Disposal
EP	Engineering Pamphlet
EPA	U.S. Environmental Protection Agency
FDEMI	Frequency Domain Electromagnetic Induction
FS	Feasibility Study
ft	foot or feet
FUDS	Formerly Used Defense Site
GPS	Global Positioning System
HHRA	Human Health Risk Assessment
IC	institutional control
INPR	Inventory Project Report
LTM	long term management
LUC	land use control
MADEP	Massachusetts Department of Environmental Protection
MA NHESP	Massachusetts Natural Heritage Endangered Species Program
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	munitions with the greatest fragmentation distance
MK	Mark
MMRP	Military Munitions Response Program
MPPEH	Material Potentially Presenting an Explosive Hazard
MRA	Munitions Response Area
MRS	Munitions Response Site
MRSPP	Munitions Response Site Prioritization Protocol
MSD	minimum separation distance
msl	mean sea level
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NG	nitroglycerin
OE	ordnance and explosives
PETN	pentaerythrite tetranitrate
PH	Priority Habitat
RAC	Risk Assessment Code
RAO	remedial action objective
RI	Remedial Investigation
SLERA	Screening Level Ecological Risk Assessment
TBC	to be considered
TCRA	Time Critical Removal Action
TDEMI	Time Domain Electromagnetic Induction
TMV	toxicity, mobility and volume
TTOR	The Trustees of Reservations
USACE	United States Army Corps of Engineers
USAESCH	United States Army Engineering Support Center, Huntsville
USC	United States Code
USDA-SCS	United States Department of Agriculture – Soil Conservation Service
USFWS	United States Fish and Wildlife Service
UU/UE	unlimited use and unrestricted exposure
UXB	UXB International, Inc.
UXO	unexploded ordnance
VRH	VRHabilis, LLC.

1.0 EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE) is conducting a Feasibility Study (FS) at the 1082.5 acre Tisbury Great Pond Munitions Response Area (MRA), Formerly Used Defense Site (FUDS), Property Number D01MA0453, located on Martha's Vineyard, Massachusetts to address munitions and explosives of concern (MEC). A Remedial Investigation (RI) was conducted from 2010 to 2011, and the results are presented under separate cover in the *Final Remedial Investigation Report for the Tisbury Great Pond Area of Investigation, Martha's Vineyard, Massachusetts* (UXB, 2014). The data collected and the conclusions drawn in the RI Report were used to develop this FS specifically addressing the Tisbury Great Pond MRA at the FUDS.

Between 1943 and 1947, the MRA was used as a practice dive bombing and strafing range. Strafing and masthead targets were constructed at the MRA in support of the U.S. Navy's fighter training program. Military practice ordnance potentially used at the MRA include 0.30 and 0.50 caliber ammunition; practice bomb series AN-Mark (MK)5, MK15, MK21, AN-MK23, and AN-MK43. Additionally, spotting charges (also called signals) may have been used in the practice bombs to permit pilots to observe bombing accuracy. Since the end of military operations in 1947, numerous reports identifying practice bombs, primarily consisting of the AN-MK23 containing spotting charges have been identified at the MRA by local residents, wildlife refuge officials, and U.S. Army Corps of Engineers (USACE) personnel (Alion, 2008). The practice bombs that remain at the MRA present a potential explosive safety hazard.

A RI was conducted from 2010-2011 to collect data necessary to determine the nature and extent of potential MEC, MD, and munitions constituents (MCs) resulting from historical military activities conducted within the MRA. To achieve the RI goals, various field investigative activities were conducted including: geophysical surveying, intrusive investigations, and environmental sampling for analysis of MCs. These activities were conducted within the RI Investigation Area, which extends beyond the boundary of the Tisbury Great Pond MRA.

During the intrusive investigation, 6 MEC items and 31 Munitions Debris (MD) items were recovered. Recovered items included intact and expended AN-MK23 3-pound practice bombs with spotting charges. Based upon these results, the Tisbury Great Pond MRA was subdivided into the following two Munitions Response Sites (MRSs):

- Tisbury Great Pond MRS (123 acres); and,
- Remaining Land and Water MRS (959 acres).

Within the land, ocean and inland water portions of the investigation area, MEC was found between 6 inches and 2 feet below ground surface (bgs). In the dunes, MEC was found at a depth of 3 feet below the base of the dune. 100% of the total quantity of MEC and MD recovered was discovered within the subsurface. No MEC items were identified during intrusive investigations performed in the Remaining Land and Water MRS.

Between October and November 2011, environmental sampling for MCs was conducted at the Investigation Area, which included the collection of discrete, biased surface and subsurface soil samples, sediment samples, and groundwater samples. Samples were analyzed for MCs, including antimony, copper, lead, nickel, and zinc, and explosive compounds previously identified as components of munitions identified within the Investigation Area. Analytical results indicated that lead is present at concentrations exceeding ecological screening criterion at three soil sample locations, but below the human health screening criterion. All other detections of metals in soil and groundwater were below human health and ecological screening criterion. No explosives were detected in soil samples collected. In groundwater, no explosives were detected. In sediment, lead and nickel were detected at concentrations exceeding ecological screening criterion at four locations, but below human health screening criterion. Based upon the Technical Justification Memorandum (AMEC, 2011), sediment and surface water background samples were required to finalize MC characterization.

Background sediment and surface water samples were collected from the northern fingers of the Tisbury Great Pond in August, 2013. The background samples were analyzed for lead and nickel, since both were detected at concentrations exceeding the ecological screening criteria in sediment. The discrete biased sediment samples found lead and nickel at concentrations of 34 mg/kg and 21 mg/kg, respectively. The background sediment concentrations (lead and nickel at 32 mg/kg and 16 mg/kg, respectively) are similar to the biased discrete sediment samples collected from Tisbury Great Pond.

A Human Health Risk Assessment and a Screening-Level Ecological Risk Assessment were performed during the RI, neither of which identified a potential risk to human or ecological receptors associated with MCs.

No remedial action was recommended for the Remaining Land and Water MRS since no evidence of military munitions-related materials was identified in this MRS during the RI. A Feasibility Study was recommended for the Tisbury Great Pond MRS to address the hazards associated with MEC discovered during the RI. No further action was identified associated with MCs at the Tisbury Great Pond MRS since it was determined that no unacceptable risk exists for human health or ecological receptors.

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) for MEC so that the decision-makers will have adequate information to select the most appropriate remedial alternative(s) for the Tisbury Great Pond MRS.

The following major steps were involved in the development of this FS:

- Identification of RAOs.
- Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered information (TBCs).
- Identification of general response actions.
- Identification and screening of potentially applicable remedial technologies and process options for the general response actions.
- Development and screening of a range of remedial alternatives for the site based on the combinations of the remedial technologies that were retained.
- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).
- Identification of the most appropriate and viable remedial alternative(s) that meet the RAO.

This FS evaluates the appropriateness and effectiveness of potential remedial alternatives to achieve the RAO.

The RAO for Tisbury Great Pond is to protect recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure within and below the dunes and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion.

The RAO facilitates the development of alternatives for the Tisbury Great Pond MRS and focuses the comparison of acceptable remedial action alternatives. The RAO also assists in clarifying an acceptable level of protection for human health and the environment. These objectives are required to meet NCP criteria.

General response actions are those actions that are evaluated to achieve the RAO. General response actions considered for the Tisbury Great Pond MRS include Land Use Controls (LUCs) and MEC clearance activities. In accordance with 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 risks to human health and the environment. MEC clearance activities include technologies used for detection, positioning, removal, disposal, and waste stream treatment (if necessary). The various LUC components and clearance technologies currently available to address MEC were screened for effectiveness, implementability, and cost to assess the viability of each technology at the MRS and to provide additional information to future decision-makers.

The following remedial alternatives were developed from the general remedial actions identified above and were evaluated for the Tisbury Great Pond MRS:

- Alternative 1 – No Action: A "no action" alternative is required by the NCP to be developed during a FS to provide a baseline for comparison against other contemplated alternatives. In Alternative 1, the government would take no action with regard to locating, removing, and disposing of any potential MEC present within the Tisbury Great Pond MRS.
- Alternative 2 – LUCs: The alternative involves the implementation of a LUCs based on public awareness and education components to provide a means to reduce MEC encounters by workers and recreational users and visitors (i.e., unqualified personnel) through behavior modification.
- Alternative 3 – Partial Subsurface Clearance with LUCs: Alternative 3 includes removal of subsurface MEC hazards within and up to 6 feet below the dunes and to 3 feet below ground surface on the land portions of the MRS. LUCs would be implemented on the uncleared portions of the inland water and ocean areas.
- Alternative 4 – Subsurface Clearance. Alternative 4 includes removal of subsurface MEC hazards within and up to 6 feet below the dunes, and to 3 feet below ground surface over the uncleared portions of the inland water and ocean areas.

In accordance with DoD Manual 4715.20 (DoD, 2012), a minimum of three alternatives for each MRS are required. One alternative must consider no action alternative, a second must consider an action to remediate the site to a condition that allows unlimited use/unrestricted exposure (UU/UE), and a third alternative will consider an action to remediate the site to a protective condition that requires LUCs. Alternative 1 meets the requirement for a no action alternative. Alternatives 2 and 3 meet the requirement for an alternative with LUCs, and Alternative 4 meets the requirement for an alternative that will achieve UU/UE.

The remedial alternatives were deemed viable for use at the MRS and were assessed in a detailed evaluation against seven of the nine criteria described in the NCP, Section 300.430. The nine evaluation criteria are:

1. Overall protectiveness of human health and the environment;
2. Compliance with ARARs;
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume of contaminants through treatment;
5. Short-term effectiveness;
6. Implementability;

7. Cost;
8. State acceptance; and,
9. Community acceptance.

State acceptance and community acceptance will be evaluated after the Proposed Plan.

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 MRS are summarized in Table 1-1. 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.

For the Tisbury Great Pond MRS, subsurface clearance (Alternative 4) of the entirety of each MRS most favorably meets all of the evaluated detailed analysis criteria as compared to other alternatives. While the Alternative 4 would require the most manpower and time to implement, it would provide the highest level of protectiveness over the long-term and will achieve the RAO of protecting recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure in and below the dunes and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion.

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Table 1-1. Comparative Analysis Summary, Tisbury Great Pond MRS Alternatives

Potential Remedial Alternative	Overall Protectiveness of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume (TMV) of Contaminants Through Treatment	Short-Term Effectiveness	Implementability	Cost[1]	State and Community Acceptance[2]
Alternative 1: No Action	Alternative 1 would not be protective because no action would be taken to reduce exposure to MEC.	There are no ARARs associated with Alternative 1.	Alternative 1 would not be effective or permanent.	Alternative l would not reduce the TMV of MEC.	There would be no additional risk to the community or workers because there are no construction or operation activities associated with Alternative 1, and it would require no time to complete.	Alternative 1 is easily implementable.	$0	TBD
Alternative 2: Land Use Controls (LUCs)	Alternative 2 would be protective through controlling exposure to possible receptors through LUCs.	There are no ARARs associated with Alternative 2.	Alternative 2 would be protective since it controls exposure through LUCs. However, it relies on exposure control rather than removal or treatment.	Alternative 2 would not reduce the TMV of MEC.	There would be no additional risk to workers, residents or the environment because there are no construction intrusive activities associated with Alternative 2. Approximately 6 months would be required to establish LUCs associated with Alternative 2.	Alternative 2 is easily implementable for the types of LUCs that were retained for consideration.	$622,000	TBD
Alternative 3: Partial Subsurface Clearance with LUCs	Alternative 3 provides protectiveness through a combination of MEC removal and LUCs controlling exposure to possible receptors.	Alternative 3 would be implemented to comply with ARARs.	Under Alternative 3, all MEC would be destroyed within the land and beach portion of the MRS, but would still require LUCs in the long-term.	Alternative 3 would be effective in the reduction of TMV through removal of all MEC within the land and beach portions of the MRS and would satisfy the statutory preference for treatment as a principal element of the remedy because MEC would be destroyed.	Implementation of Alternative 3 will increase in risk to workers and the environment since the work involves exposure to potentially explosive items. These risks would be mitigated through use of SOPs for conducting MEC removals. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Some vegetation clearance is anticipated, therefore impacts to the environment are possible. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Action Work Plan. It is estimated that partial clearance under Alternative 3 would require approximately 5 months of field work to implement and 6 months would be required to establish LUCs.	Alternative 3 would be easily implemented at the MRS. Removal of MEC within the MRS was implemented effectively during the RI. Coordination with MADEP, MA NHESP and TTOR is required for this alternative.	$8,079,000	TBD
Alternative 4: Subsurface Clearance	Alternative 4 provides protectiveness by removing the MEC hazard at the MRS.	Alternative 4 would be implemented to comply with all ARARs.	Alternative 4 would remove MEC hazards from within the entirety of the MRSs and would be the most effective and permanent remedial alternative over the long-term because it would eliminate risk regardless of the future use of the property.	Alternative 4 would be the most effective in reducing the TMV of MEC because all detectable MEC throughout the entirety of the MRS would be destroyed and would satisfy the statutory preference for treatment as a principal element.	Implementation of Alternative 4 will increase in risk to workers and the environment since the work involves exposure to potentially explosive items. These risks would be mitigated through use of SOPs for conducting MEC removals. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Some vegetation clearance is anticipated, therefore impacts to the environment are possible. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Action Work Plan. It is estimated that clearance under Alternative 4 would require approximately 6 months of field work.	Alternative 4 would be easily implemented at the MRS. Removal of MEC within the MRS was implemented effectively during the RI. Coordination with MADEP, MA NHESP and TTOR is required for this alternative.	$9,868,000	TBD

Notes: Costs are detailed in Appendix D. Costs provided here include Remedial Alternative Costs plus review Costs ($42,000 per review) to provide a meaningful comparison. However, review costs are calculated separately from the remedial alternative.

[2] The modifying criteria will be evaluated after the Proposed Plan following review and input from these parties.

TBD = to be determined

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2.0 INTRODUCTION

This report documents the results of a Feasibility Study (FS) conducted within the Tisbury great Pond Munitions Response Area (MRA), Formerly Used Defense Site (FUDS) Property Number D01MA0453, located on Martha's Vineyard, Massachusetts for munitions and explosives of concern (MEC) (see Figure 2-1). This FS was performed in support of the Department of Defense (DoD) Military Munitions Response Program (MMRP). UXB International, Inc. (UXB) was authorized to conduct the FS through a United States Army Engineering Support Center, Huntsville (USAESCH) Contract, No. W912DY-04-D-0019, Task Order No. 006. The FS was conducted in accordance with the procedures established for managing and executing military munitions response actions in the Draft Engineer Pamphlet No. 1110-1-18 (United States Army Corps of Engineers [USACE], 2006) presented in Interim Guidance 06-04, the Final Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance (USAEC, 2009), 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 one munitions response site (MRS) within the Tisbury Great Pond MRA: the Tisbury Great Pond MRS (123 acres). The MRS boundary is depicted on Figure 2-2, which also shows a second MRS (Remaining Land and Water MRS) consisting of 959 acres. Figure 2-3 details the Tisbury Great Pond MRS. No MEC items have been discovered in the Remaining Land and Water MRS and was therefore recommended for no DoD action. The results of the RI (RI) are documented in the *Final Remedial Investigation Report for the Tisbury Great Pond Area of Investigation, Martha's Vineyard, Massachusetts* (UXB, 2014).

The RI/FS process was developed in response to Comprehensive Environment Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act of 1986. 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).

2.1 Purpose

The purpose of the FS for the Tisbury Great Pond 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 alternative is expected to mitigate, reduce, or eliminate unacceptable risks to human health and the environment from MEC at the MRS based on the current and intended future use of the property.

Only properties transferred from DoD control before 17 October 1986 are FUDS eligible. 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., Engineering Pamphlet [EP] 1110-1-18, ER 200-3-1, *Management Guidance for the DERP* [DoD, 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.

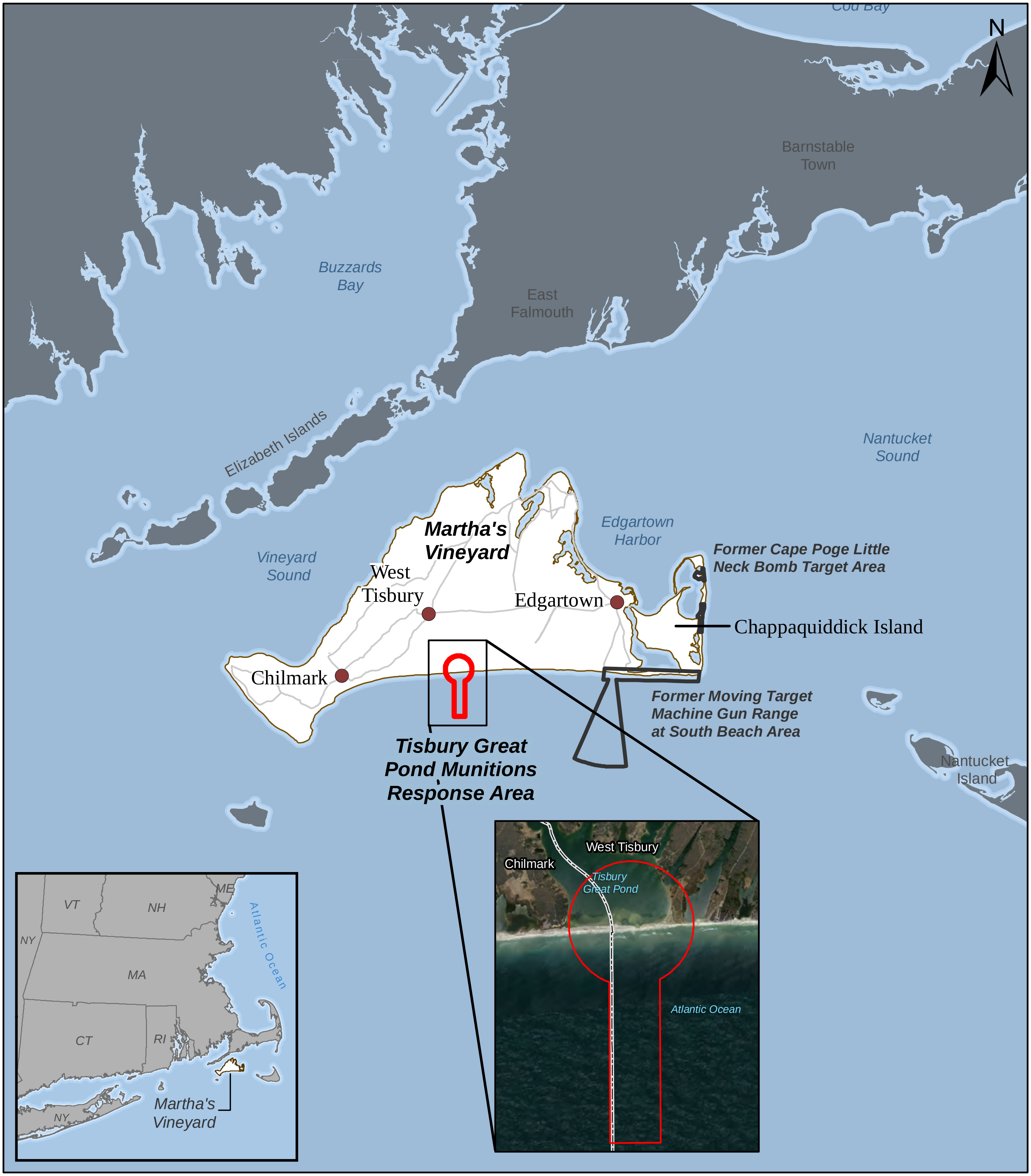
The RI identified MEC at the Tisbury Great Pond MRS and an FS was recommended following the RI to evaluate future response action alternatives with regard to MEC hazards.

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

- Identification of Identification of Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered information (TBCs) (Section 3).
- Identification of general response actions (Section 4).
- Identification of RAOs (Section 4).
- Identification and screening of potentially applicable remedial technologies and process options for the general response actions (Section 4).
- Development and screening of a range of remedial alternatives for the MRSs based on combinations of the remedial technologies that were retained (Section 5).
- Performance of a detailed analysis for each of the remedial alternatives using the evaluation criteria as required by the NCP (Section 6).
- Identification of the most appropriate remedial alternative(s) that meet the RAO through a comparative analysis of all remedial alternatives using the NCP criteria (Section 6).

2.2 Historical Information

The following subsections provide a summary of the MRA background and history and previous investigations, including the RI, that have been conducted within the MRA.



US Army Corps of Engineers

FIGURE 2-1

Site Location - Martha's Vineyard, MA

0 2.5 5 10 15 Miles

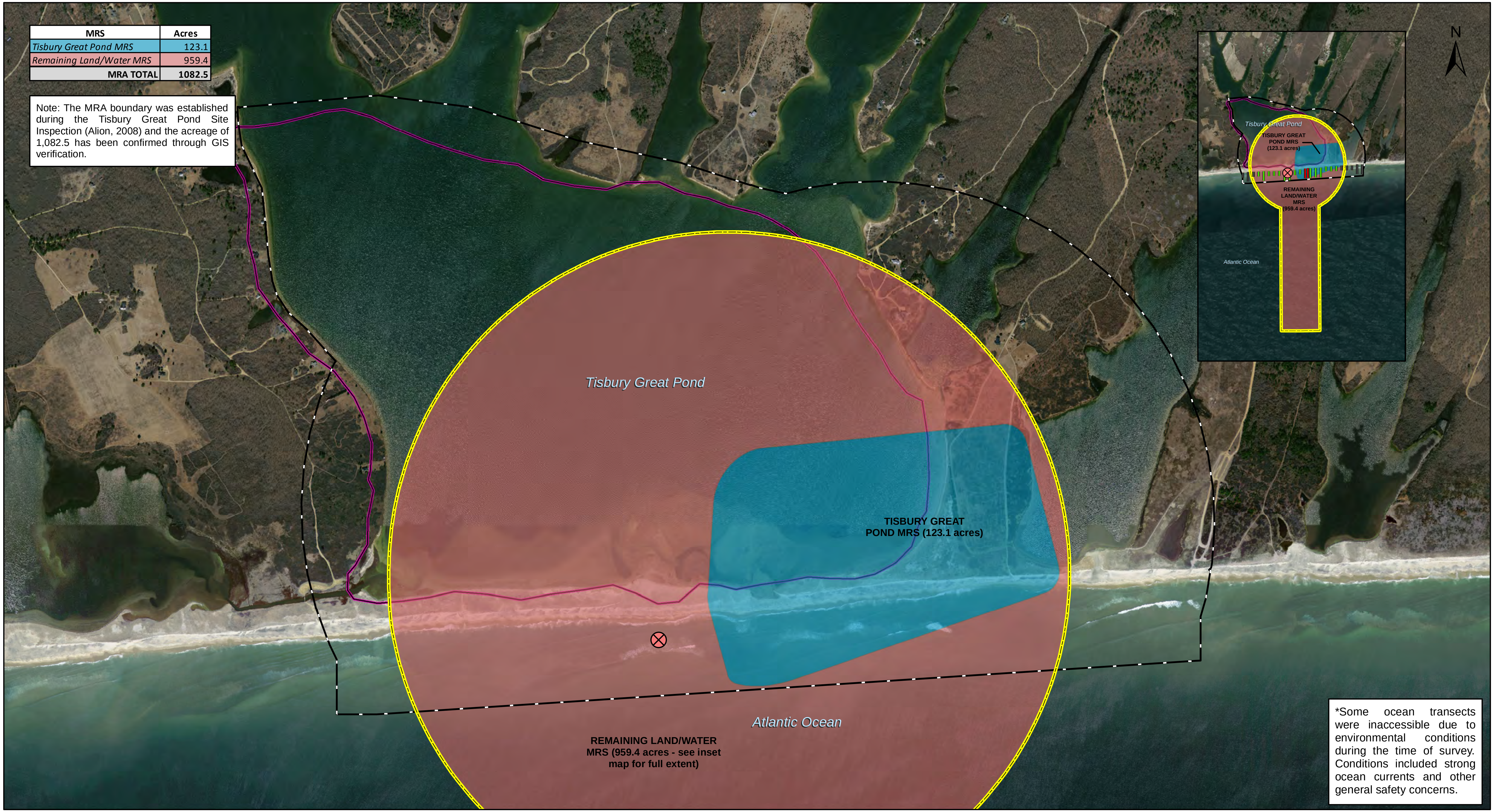
0 5 10 15 20 25 Kilometers

UXB

amec

NOTES:
Base map data source: ESRI

10/16/2014	Rev:	Tisbury_MV_Island_ Remedial_Inv_Rpt.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000



MRS	Acres
Tisbury Great Pond MRS	123.1
Remaining Land/Water MRS	959.4
MRA TOTAL	**1082.5**

Note: The MRA boundary was established during the Tisbury Great Pond Site Inspection (Alion, 2008) and the acreage of 1,082.5 has been confirmed through GIS verification.

*Some ocean transects were inaccessible due to environmental conditions during the time of survey. Conditions included strong ocean currents and other general safety concerns.

⊗ Former Bombing Target

▭ Tisbury Great Pond MRA

▭ Tisbury Great Pond FUDS Boundary

▭ Tisbury Great Pond Investigation Area

US Army Corps of Engineers

FIGURE 2-2

Tisbury Great Pond Munitions Response Area
Martha's Vineyard, MA

0 100 200 400 600 Meters

0 500 1,000 1,500 2,000 Feet

UXB amec

NOTES:
2009 Aerial Data Source: MassGIS

10/17/2014	Rev:	Tisbury_Revised_MRS_FS.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000

* Total Inland Water acreage includes the portion of inland water within Tisbury Great Pond and the portion within Long Cove.

US Army Corps of Engineers

NOTES:
2009 Aerial Data Source: MassGIS

UXB amec

0 400 800 1,200 1,600 2,000 Feet

0 75 150 225 300 375 Meters

FIGURE 2-3

Tisbury Great Pond MRS - Tisbury Great Pond Munitions Response Area, Martha's Vineyard, MA

10/22/2014	Rev:	Drawn: JBO	Chk: DMS	Tisbury_TGP_MRS_Divided_FS.mxd	PROJ: 562910000

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2.2.1 Munitions Response Area Background

Between August 1943 and July 1947, the MRA was used as a practice dive bombing and strafing range. The site was utilized to support the U.S. Navy’s fighter training program at Quonset Point Naval Air Station, Rhode Island and the Naval Auxiliary Air Station, Martha’s Vineyard, Massachusetts. During the initial operational period of the range, strafing and masthead targets were constructed to allow student pilots to develop their gunnery and bombing skills. It is believed that military activities ceased at the site by the end of World War II. On 27 March 1947, the site was reinstated for practice bombing use by the carrier fleet based at Newport, Rhode Island. A masthead target was constructed on the barrier beach south of the pond (UXB, 2011). On 29 July 1947, the commander of the 1st Naval District reported that the Tisbury Great Pond Area was excess to the needs of the U.S. Navy and the area was closed, the targets were removed, and the area was decontaminated (Alion, 2008).

Military practice ordnance potentially used at the MRS include:

- 0.30 and 0.50 caliber ammunition;
- Miniature practice bombs; AN-Mark(MK)5 Mod 1, AN-MK23, and AN-MK43; and,
- Practice 100 - 500 lb general purpose bombs; MK5, MK15, and MK21 (USACE, 1999).

Records do not indicate that the property was ever used to store, transport, treat, or dispose of associated munitions used on the property. Following site closure and land transfer, Tisbury Great Pond was developed into a shellfish harvest area (Alion, 2008).

2.2.2 Previous Investigations

Investigations conducted prior to the 2011 RI at the MRA include the following, which are detailed in the following subsections:

- Inventory Project Report (INPR), USACE, 1996;
- Archives Search Report (ASR), USACE, 1999;
- ASR Supplement, USACE, 2004b;
- Site Inspection Report, Alion Science and Technology (Alion), 2008; and,
- Emergency Response, VRHabilis, LLC (VRH), 2009 and 2011.

2.2.2.1 Inventory Project Report

In 1996, the USACE issued an INPR for the Tisbury Great Pond Target Area. The INPR concluded that the property was used as a practice bombing and strafing range. The report stated that only practice bombs were known to be used at the site; including, practice bombs

AN-MK23, AN-MK43, MK15, and MK21, and the spotting charge AN-MK4 may have been used with each of these practice munitions. Additionally, small arms including 0.50 caliber wing-mounted munitions were used at the site. Based on the possibility that ordnance may still be present, the property was determined to be eligible for cleanup under the FUDS program. The Findings and Determination of Eligibility for the site established the eligibility of 514 acres as a FUDS. A MMRP project was proposed and the INPR identified a MEC category hazard potential. The INPR assigned a Risk Assessment Code of 2 for the site and recommended further action by USAESH (UXB, 2011).

2.2.2.2 Archives Search Report

In 1997, the USACE prepared an ASR that documented a historical records search and site inspection for ordnance and explosives (OE) presence located at Tisbury Great Pond, Martha's Vineyard, Massachusetts. The purpose of this investigation was to characterize the site for potential OE presence to include conventional ammunition and chemical warfare material. The investigation was conducted through the evaluation of historical records, interviews, and on-site visual inspections (USACE, 1999).

Interviews conducted indicate that no explosions were heard during practice bombings, the flight lines were north to south (Tisbury Great Pond to ocean), and multiple residents found various types of practice bombs in and along Tisbury Great Pond. One of the original landowners, Deloris Bissell Bigelow, requested a cleanup from the Navy of the metal debris on her 11.1 acre property after it was returned. A site inspection and historical photographs confirmed the presence of ordnance on 24 acres of land located around the practice bombing and strafing target area. The site inspection team discovered what appeared to be an MK15 series 100-lb sand or water-filled bomb. Additionally, Shellfish Wardens provided a 1992 photograph of items discovered and removed from the pond-side shoreline in this area. Items present in the photographs are MK5 and AN-MK23, 3-lb practice bombs and broken 300-lb general purpose bomb bodies (USACE, 1999). The ASR determined that there was no evidence of chemical warfare storage, usage, or disposal (USACE, 1999).

2.2.2.3 Archives Search Report Supplement

In 2004, the USACE prepared an ASR Supplement to combine with the information regarding specific munitions presented in the ASR to generate a list of military munitions types and composition for Tisbury Great Pond. USACE technical documents, manuals, and other resources were used to identify a list of MCs associated with each munitions type. The report indicated that the associated MCs include nitroglycerin (NG), 2,4-dinitrotoluene (2,4-DNT), 2,6-dintitrotoluene (2,6-DNT), 2,4,6-trinitrotoluene (2,4,6-TNT) and its degradation compounds 2-

amino-4,6-dinitrotouene and 4-amino-2,6-dinitrotoluene and the metals, antimony, copper, iron, lead, nickel, strontium and zinc.

The ASR Supplement also assigned a Risk Assessment Code (RAC) score to the site. RAC score indicates the level of MEC risk associated with a site, with a score of 1 indicated a site with the highest risk and a score of 5 indicating a site with the lowest risk. Tisbury Great Pond received a score of 2. The ASR Supplement established a MRS boundary (USACE, 2004).

2.2.2.4 Site Inspection Report

In September 2008, a Site Inspection Report was prepared by Alion to document the site inspection findings at the Tisbury Great Pond. The site inspection was conducted to determine whether further response was necessary at the site. The scope of the investigation was restricted to the evaluation of the presence of MEC or MC related historical use of the property. Activities associated with this investigation included a records review, qualitative site reconnaissance, and environmental sampling (Alion, 2008).

A qualitative site reconnaissance was conducted on January 29, 2008 on approximately 4.49 acres of land and water. During the reconnaissance, analog geophysics was conducted and visual observations were made. The field sampling approach included magnetometer-assisted reconnaissance following a meandering path in and around sampling locations to confirm the location of the practice bombing and strafing targets and identify whether MEC, munitions debris (MD), or other areas of interest were present. During the reconnaissance, one underwater anomaly was observed in the eastern portion of the pond and one subsurface anomaly was detected. These anomalies were not investigated since they were not visible from the surface.

A qualitative Screening Level Ecological Risk Assessment (SLERA) was also conducted for MEC identified at Tisbury Great Pond. This assessment was based on results and findings from the site inspection qualitative reconnaissance, the INPR, ASR, and the ASR Supplement. The potential risk posed by MEC was based on three factors, including the presence of a MEC source, accessibility or pathway presence, and potential receptors. Based on the available information, the site was given a low-to-moderate risk.

Finally, MC sampling and risk screening was conducted for the site. MC sampling included six discrete surface soil sample locations, two background surface soil sample locations, one discrete subsurface soil sample location, five sediment sample locations, and two background sediment sample locations. These samples were located on the beach near Long Cove Point, in the vicinity of the practice ranges, and along the shoreline of the pond. The samples were analyzed for associated explosives and metals. The human health screening did not identify any Chemicals of Potential Concern for the environmental media sampled. Based upon the SLERA, antimony and lead in surface soil and strontium in surface water were identified as Chemicals of

Potential Ecological Concern. Only antimony and lead in surface soil were determined to be present at potentially unacceptable risks to ecological receptors. The Site Inspection recommended an RI/FS (Alion, 2008).

2.2.2.5 Emergency Response

Between 19 August 2009 and 13 July 2011, VRH and Navy Explosive Ordnance Disposal (EOD) responded to six emergency calls associated with potential ordnance. The four items discovered were determined to be free of explosive hazard and were removed and secured. The details of the emergency responses are presented in Table 2-1.

Table 2-1. Emergency Responses at the Tisbury Great Pond Area

Date	Location	Quantity	Ordnance Description	Response Action
19-08-2009	Long Point	1	Ordnance item at the West Tisbury Great Pond "cut." Nose fuse was visible, but the rest of the item was indiscernable. Determined to be potentially hazardous.	Navy EOD destroyed the item by counter charging. Navy EOD reported that item was a high explosive round.*
20-08-2009	Long Point	1	Ordnance item at the West Tisbury Great Pond "cut."	Due to high tide and strong currents, debris was left in place.
23-02-2011	Tisbury Great Pond	3	Metal debris found in the vicinity of the cut. Determined to be munitions debris with no explosive hazard.	Removed and placed in a secure container in Edgartown.
24-02-2011	Tisbury Great Pond	3	Metal debris found in the vicinity of the cut. Determined to be munitions debris with no explosive hazard.	Removed and placed in a secure container in Edgartown.
26-02-2011	Tisbury Great Pond	2	Metal debris found in the vicinity of the cut. Determined to be munitions debris with no explosive hazard.	Removed and placed in a secure container in Edgartown.
13-7-2011	Long Point	6	Metal debris found on the beach. Two of the items were clearly ordnance debris. No explosive hazard related to the items.	The debris was removed and disposed.

Notes:
EOD – Explosives Ordnance Disposal
MK – Mark
VRH - VRHabilis, LLC
* 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 difficult to determine if an item was MD or MEC based on the resulting explosive during detonation.

2.3 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 MC risks. Field activities were conducted at the Investigation Area, which extends beyond the boundary of the Tisbury Great Pond MRA, to achieve the project Data Quality Objectives established in the *Final Remedial Investigation Work Plan* (UXB, 2011), and to determine if further action is required under the CERCLA process.

2.3.1 Nature and Extent of MEC

To characterize the nature and extent of MEC, various field investigative activities were conducted including geophysical surveying and intrusive investigations. A wide area assessment was initially performed to help identify high density areas of geophysical anomalies that might be indicative of an area previously used as a military target, aid in determining the extent of potential MEC contamination, and focus subsequent detailed intrusive investigations. The wide area assessment consisted of:

- Analog density transects in the upland areas using hand-held analog instruments to minimize the amount of brush clearing;
- Digital Geophysical Mapping (DGM) transects on the beach and dune areas where no vegetation clearing was required;
- Underwater DGM in the inland water areas; and,
- Analog magnetometer survey and intrusive investigation (mag and dig) ocean transects.

This work was supplemented with an airborne magnetometry (AirMag) survey performed using a magnetometer array mounted to a helicopter. The AirMag was flown over portions of the land, beach, and shallow inland water (surf zone) at 3 to 10 feet (ft) above the surface.

Data collected during the wide area assessment was subsequently used to identify site grids for additional DGM surveying and intrusive investigation within inland water, land, and beach areas. Based upon the results of the wide area assessment, anomalies were identified, mapped, and analyzed to identify high-density anomaly areas. The grids were sited in areas of high, medium, and low anomaly densities to refine the extent, and establish the nature of MEC contamination through subsequent intrusive investigations. High-density anomaly areas were then used to determine the size and location of grids over which additional DGM data would be collected. Fifty-two DGM land and beach grids and 18 inland DGM water grids were located within the investigation area. Geophysical data were collected in the grids by towing the electromagnetic (EM) sensor system by hand (land and beach grids) or by boat (inland water grids) across the surface. DGM data collected within the grids were evaluated and a list of anomalies to be intrusively investigated was generated.

The intrusive investigation was conducted by reacquiring the anomaly locations selected for intrusive investigation and excavating the locations to identify the source of the anomaly. Excavation of land/beach locations were conducted by UXO technicians and excavation of inland water locations were conducted by UXO divers. Due to the dynamic nature of the ocean surf zone, a "Mag and Dig" technique was used for ocean transects. Divers identified anomalies on transects using an underwater hand-held analog instrument, and subsequently excavated each anomaly as it was found. This methodology provided both wide area assessment and intrusive investigation to provide nature and extent data. Once identified, debris was classified as non-MD, cultural artifacts, MD, or MEC. During the intrusive investigation, 6 MEC and 31 MD items were recovered from land, beach, inland water, and ocean areas (Figure 2-5). MEC items included AN-MK23 3-lb practice bombs with intact spotting charges, and MD items included expended AN-MK-23 3-lb practice bombs and remnants of 100-lb practice bombs including an inert spotting charge. MEC and MD items discovered during the intrusive investigation were removed, demilitarized, and properly disposed.

Within the land, ocean and inland water portions of the investigation area, MEC was found between 6 inches and 2 feet below ground surface (bgs). In the dunes, MEC was found at a depth of 3 feet below the base of the dune. 100% of the total quantity of MEC and MD recovered was discovered within the subsurface.

No MEC items were identified during intrusive investigations performed in the Remaining Land and Water MRS.

2.3.2 Ocean Transport Study

To better understand the movement of MEC items in the surf zone and support the characterization of nature and extent of MEC at the Investigation Area, an ocean transport study was conducted. The Tisbury and Chilmark Shellfish Departments breach the barrier beach that separates Tisbury Great Pond from the Atlantic Ocean several times a year to hydraulically connect the pond to the ocean to allow the pond to discharge freshwater to the Atlantic Ocean and allow saltwater enter the pond. The breach locations started on the western edge of the pond and move eastward with each successive breach east of the previous one. The most recent breaches have cut through the dune on the eastern edge of the pond. The study including a MEC transport acoustic transponder (pinger) survey conducted from 12 December 2010 through 04 November 2011, and a numerical modeling study of the currents produced during of one of the “cuts” with field work completed 11 November, 2011. The objectives of the study were to:

1. Determine whether MPPEH can be transported by ocean waves;
2. Determine the area within the coastal surf zone where wave-driven MPPEH transport is most likely to occur; and,
3. Determine whether prevailing wave-induced erosion is likely to continue exposing and transporting MPPEH if any remain buried under the existing beach; if so, determine the sections of beach that might be most vulnerable.
4. Determine the theoretical distance MEC/MD items could be carried seaward from the cut or wave action to ensure transect lengths bounded this limit.

The pingers in the grid west of the previous cut were interrogated, but no return signal was identified. Of the 4 pingers in the east grid, two responded (one 100-lb bomb simulant and one spotting charge simulant), but only the 100-lb bomb simulant was recovered. The spotting charge simulant migrated laterally beyond umbilical length and was not able to be recovered. The second 100-lb bomb simulant was located during mag/dig transect investigation and the pinger batteries were expired. Both 100-lb bomb simulants were found in the location they were placed, but both had become buried about 8 inches below the surface of the sand.

The results of the numerical modeling indicated that there is a potential to transport UXO either seaward or into the pond based on the tide cycle.

2.3.3 Munitions Constituents

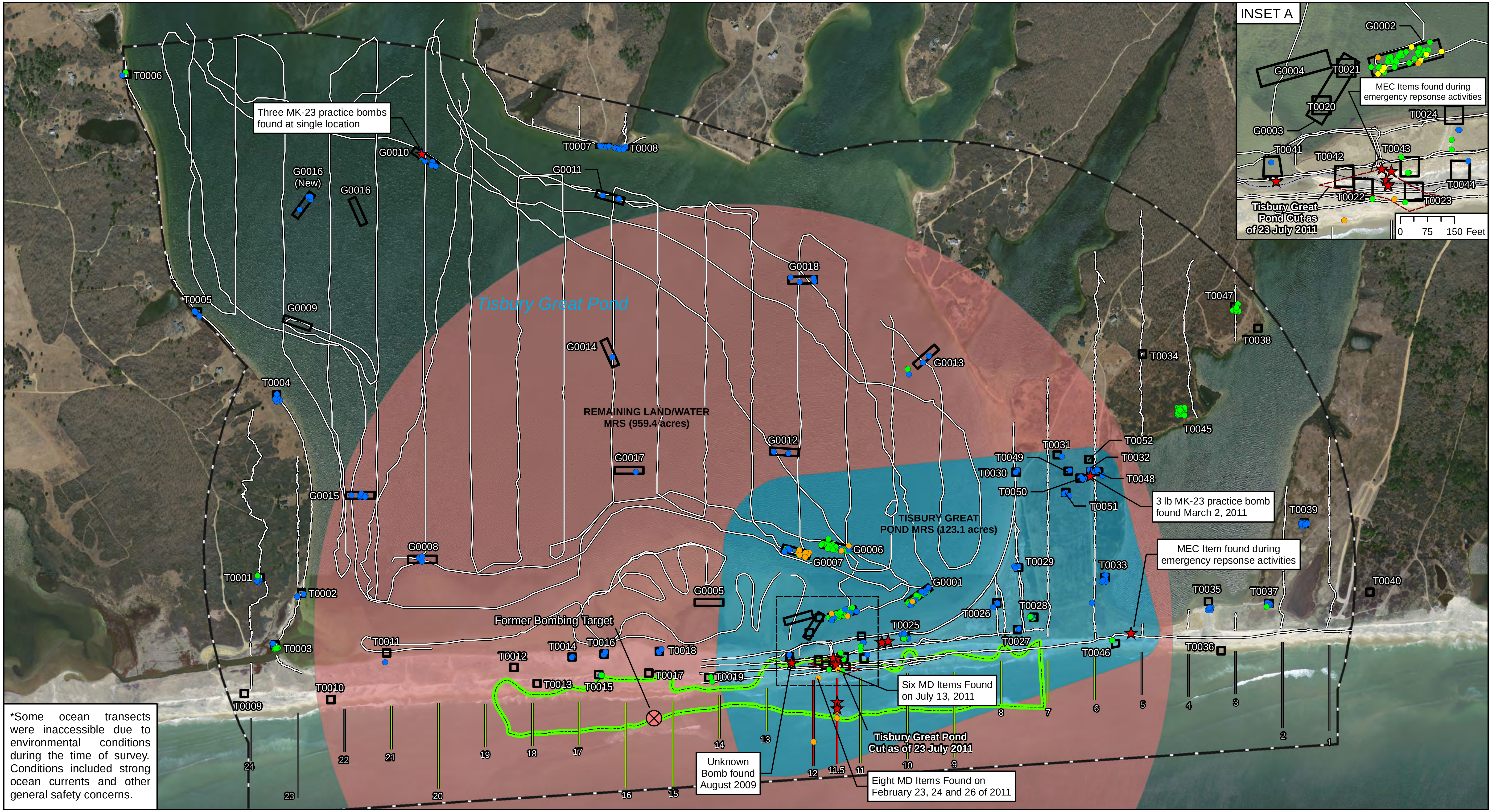
Between 13 October and 2 November 2011, environmental sampling for MCs was conducted at the Investigation Area, which included the collection of discrete, biased surface and subsurface soil samples and groundwater samples. Sample locations are shown on Figure 2-5. Samples were analyzed for MCs, including antimony, copper, lead, nickel, and zinc, and explosive compounds, including pentacrythrite tetranitrate (PETN) and nitroglycerin (NG), previously identified as components of munitions identified within the area. Analytical results indicated that lead is present at concentrations exceeding ecological screening criterion at three soil sample locations, but below the human health screening criterion. All other detections of metals in soil and groundwater were below human health and ecological screening criterion. No explosives were detected in soil samples. In groundwater, no explosives were detected. In sediment, lead and nickel were detected at concentrations exceeding ecological screening criterion at four locations, but below human health screening criterion. Sediment and surface water background samples were required to finalize MC characterization.

Background sediment and surface water samples were collected from the northern fingers of the Tisbury Great Pond on 8 August, 2013. The background samples were analyzed for lead and nickel, since both were detected at concentrations exceeding the ecological screening criteria in sediment. The discrete biased sediment samples found lead and nickel at concentrations of 34 mg/kg and 21 mg/kg, respectively. The background sediment concentrations (lead and nickel at 32 mg/kg and 16 mg/kg, respectively) are similar to the biased discrete sediment samples collected from Tisbury Great Pond.

Human Health Risk Assessment (HHRA) was conducted for the Investigation Area to provide a comprehensive assessment of potential risks to individuals that may be exposed to hazardous constituents at the Investigation Area. The HHRA concluded that there is no unacceptable risk to human health from MC. A SLERA was performed to evaluate risks posed to ecological receptors (plants, invertebrates, herbivores, predators, and marine receptors) due to exposures to residual MCs. Lead was identified at concentrations exceeding ecological screening criterion in surface and subsurface soil. Lead levels in surface soil exceeded the ecological soil screening levels for insectivorous birds; however, further evaluation of conservative assumptions indicated that the potential for risk from this metal is negligible. No high explosive compounds or their by-products were detected in soil.

Lead and nickel were identified at concentrations exceeding ecological screening criterion in sediment in both investigation and background samples. Although the concentrations of lead and nickel in surface sediment from Tisbury Great Pond exceeded the USEPA Region 3 ecological screening levels for those metals, their potential for risk was found to be insignificant based on the 95% upper confidence level concentrations. In addition, background sediment concentrations also exceeded the USEPA Region 3 ecological screening levels for lead and nickel.

Based on the low concentrations of MCs within soil, sediment, and groundwater samples, and the results of this assessment, it was concluded that none of the MCs evaluated pose a potential for risk to ecological receptors.



MEC Items found during emergency repsonse activities

Three MK-23 practice bombs found at single location

3 lb MK-23 practice bomb found March 2, 2011

MEC Item found during emergency repsonse activities

Six MD Items Found on July 13, 2011

Unknown Bomb found August 2009

Eight MD Items Found on February 23, 24 and 26 of 2011

*Some ocean transects were inaccessible due to environmental conditions during the time of survey. Conditions included strong ocean currents and other general safety concerns.

US Army Corps of Engineers

FIGURE 2-4

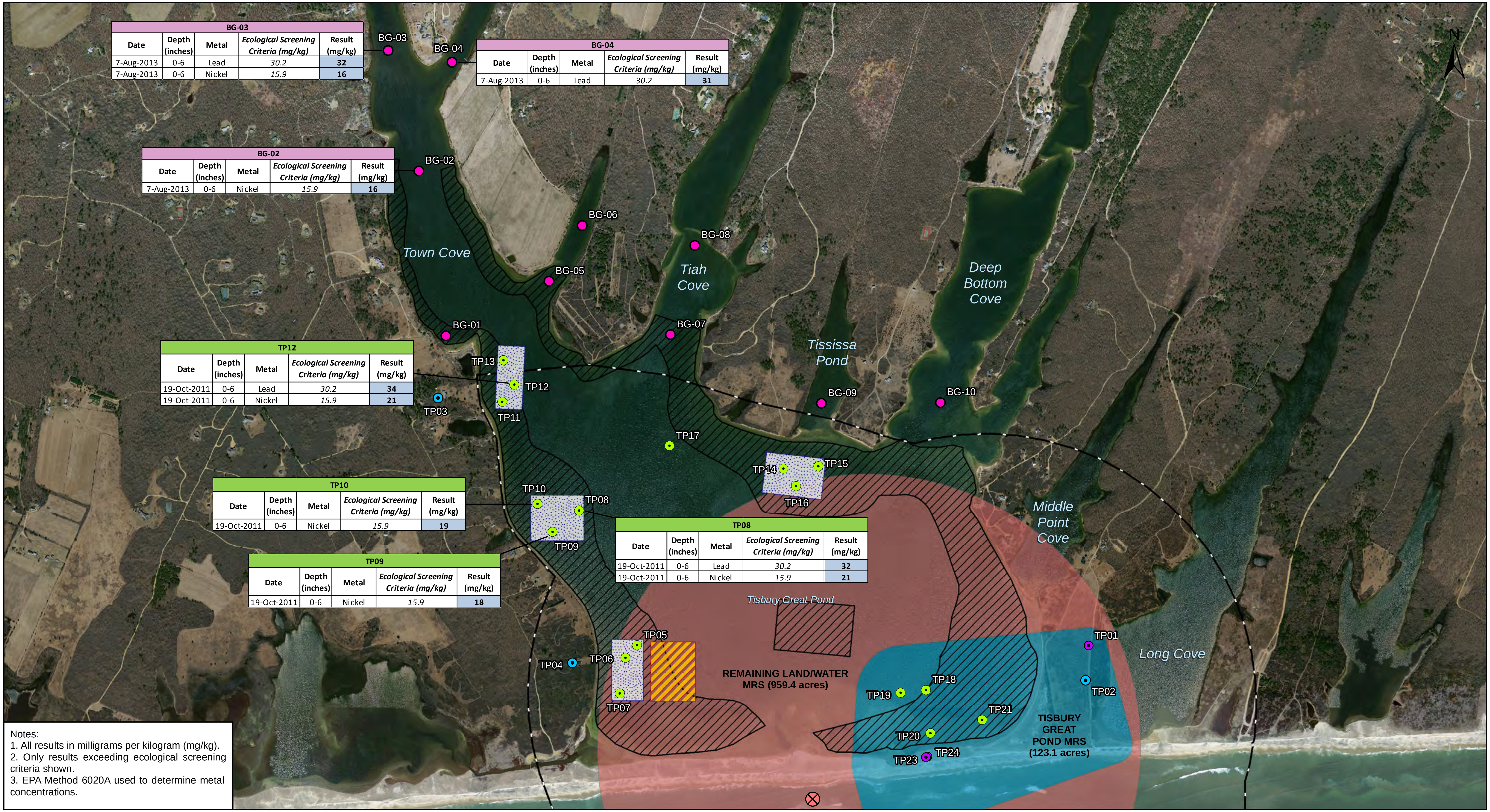
Nature and Extent of MEC Identified During RI
Tisbury Great Pond Munitions Response Area, Martha's Vineyard, MA

0 100 200 300 400 500 600 700 Meters
0 600 1,200 1,800 2,400 Feet

UXB amec

NOTES:
2009 Aerial Data Source: MassGIS

10/22/2014	Rev:	Tisbury_All_Activities_Results_FS.mxd
Drawn: JBO	Chk: DMS	PROJ: 562910000



BG-03

Date	Depth (inches)	Metal	Ecological Screening Criteria (mg/kg)	Result (mg/kg)
7-Aug-2013	0-6	Lead	30.2	32
7-Aug-2013	0-6	Nickel	15.9	16

BG-04

Date	Depth (inches)	Metal	Ecological Screening Criteria (mg/kg)	Result (mg/kg)
7-Aug-2013	0-6	Lead	30.2	31

BG-02

Date	Depth (inches)	Metal	Ecological Screening Criteria (mg/kg)	Result (mg/kg)
7-Aug-2013	0-6	Nickel	15.9	16

TP12

Date	Depth (inches)	Metal	Ecological Screening Criteria (mg/kg)	Result (mg/kg)
19-Oct-2011	0-6	Lead	30.2	34
19-Oct-2011	0-6	Nickel	15.9	21

TP10

Date	Depth (inches)	Metal	Ecological Screening Criteria (mg/kg)	Result (mg/kg)
19-Oct-2011	0-6	Nickel	15.9	19

TP09

Date	Depth (inches)	Metal	Ecological Screening Criteria (mg/kg)	Result (mg/kg)
19-Oct-2011	0-6	Nickel	15.9	18

TP08

Date	Depth (inches)	Metal	Ecological Screening Criteria (mg/kg)	Result (mg/kg)
19-Oct-2011	0-6	Lead	30.2	32
19-Oct-2011	0-6	Nickel	15.9	21

Notes:
1. All results in milligrams per kilogram (mg/kg).
2. Only results exceeding ecological screening criteria shown.
3. EPA Method 6020A used to determine metal concentrations.

- ● Background Sediment Sample Location
- ● Sediment Sample Location
- ● Groundwater Sample
- ● Discrete Surface or Subsurface Soil Sample
- ⊗ Former Bombing Target
- ▨ Oyster Grow Out Equipment
- ▨ Shell Reef
- ▨ Oyster Growth Area

US Army Corps of Engineers

FIGURE 2-5

MC Sampling Results Exceeding Ecological Screening Criteria - Tisbury Great Pond Munitions Response Area, Martha's Vineyard, MA

0 100 200 400 600 800 Meters
0 500 1,000 1,500 2,000 2,500 Feet

UXB
amec

NOTES:
2009 Aerial Data
Source: MassGIS

10/22/2014
Rev:
Tisbury_MC_Samp_Results_FS.mxd
Drawn: JBO
Chk: DMS
PROJ: 562910000

2.3.4 Munitions Response Site Prioritization Protocol

The Munitions Response Site Prioritization Protocol (MRSPP) ranking was revised during the RI to assign a relative risk for the individual MRSs. This ranking system uses scores of 1 through 8, 1 indicating the highest potential hazard and 8 indicating the lowest potential hazard, to determine a relative priority for response activities. The priorities do not have specific assigned actions. Ultimately, the MRS Priority is used to determine the future funding sequence of MRSs for further munitions response action.

The Tisbury Great Pond MRS received a MRSPP priority or rating of 5. The MRSPP score for the Remaining Land and Water MRS received a priority or rating of No Known or Suspected Hazard.

2.3.5 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 (MEC HA) Methodology* (EPA, 2008). This document is designed to be used as the CERCLA hazard assessment methodology for MRSs where there is an explosive hazard from the known or suspected presence of MEC.

The MRA was characterized using the MEC HA method based on the results of the RI, and the historical information available from prior studies and removal actions. The results of these MEC HA is summarized in Table 2-2. Under current conditions, the land and beach portion of the MRA received a hazard level category of 1, indicating the highest potential explosive hazard conditions are present at the MRA. This information will provide the baseline for any assessment of response alternatives to be conducted. Note that the total MEC HA score and the associated hazard level are *qualitative references only* and should not be interpreted as quantitative measures of explosive hazard.

Table 2-2. MEC HA Scoring Summary for the Tisbury Great Pond MRA

<table>
<tr><th colspan="5">Scoring Summary</th></tr>
<tr><td>Site ID:</td><td colspan="2">FUDS No. D01MA0453 (Tisbury Great Pond MRA)</td><td colspan="2">a. Scoring Summary for Current Use Activities</td></tr>
<tr><td>Date:</td><td>8/1/2013</td><td colspan="3">Response Action Cleanup: No Response Action</td></tr>
<tr><th colspan="2">Input Factor</th><th colspan="2">Input Factor Category</th><th>Score</th></tr>
<tr><td colspan="2">Energetic Material Type</td><td colspan="2">High explosive and low explosive filler in fragmenting rounds</td><td>100</td></tr>
<tr><td colspan="2">Location of Additional Human Receptors</td><td colspan="2">Inside the Munitions Response Site or inside the Explosives Safety Quantity Distance arc</td><td>30</td></tr>
<tr><td colspan="2">Site Accessibility</td><td colspan="2">Full Accessibility</td><td>80</td></tr>
<tr><td colspan="2">Potential Contact Hours</td><td colspan="2">≥1,000,000 receptor hours per year</td><td>120</td></tr>
</table>

<table>
<tr><th colspan="4">Scoring Summary</th></tr>
<tr><td>Site ID:</td><td>FUDS No. D01MA0453 (Tisbury Great Pond MRA)</td><td colspan="2">a. Scoring Summary for Current Use Activities</td></tr>
<tr><td>Date:</td><td>8/1/2013</td><td colspan="2">Response Action Cleanup: No Response Action</td></tr>
<tr><th colspan="2">Input Factor</th><th>Input Factor Category</th><th>Score</th></tr>
<tr><td colspan="2">Amount of munitions and explosives of concern</td><td>Target Area</td><td>180</td></tr>
<tr><td colspan="2">Minimum MEC Depth Relative to Maximum Intrusive Depth</td><td>Baseline Condition: MEC located surface and subsurface.
After Cleanup: Intrusive depth overlaps with subsurface MEC</td><td>240</td></tr>
<tr><td colspan="2">Migration Potential</td><td>Possible</td><td>30</td></tr>
<tr><td colspan="2">MEC Classification</td><td>Unexploded Ordnance</td><td>110</td></tr>
<tr><td colspan="2">MEC Size</td><td>Small</td><td>40</td></tr>
<tr><td colspan="3" align="right">Total Score</td><td>930</td></tr>
<tr><td colspan="3" align="right">Hazard Level Category</td><td>1</td></tr>
</table>

2.3.6 Environmental Setting

2.3.6.1 Climate

Martha's Vineyard has a temperate marine climate. Although Martha's Vineyard's weather is typically moderate, there are occasions where the island experiences extreme weather conditions such as blizzards and hurricanes. Martha's Vineyard's generally experiences a delayed spring season, being surrounded by an ocean that is still cold from the winter; however, it is also known for an exceptionally mild fall season, due to the ocean remaining warm from the summer. The highest temperature ever recorded on Martha's Vineyard was 99 degrees Fahrenheit in 1948, and the lowest temperature ever was -9 degrees Fahrenheit in 1961 (USACE, 2009).

Precipitation on Martha's Vineyard and the islands of Cape Cod and Nantucket is the lowest in the New England region, averaging slightly less than 40 inches per year. This is due to storm systems that move across western areas, building up in mountainous regions, and dissipating before reaching the coast (USACE, 2009).

2.3.6.2 Geology

The MRA and the island of Martha's Vineyard are relics of the last ice age and the warming trends that followed. Repeated glaciations scraped soil and rock from the mainland of New England. Eighteen-thousand years ago, the glaciers reached their southernmost extent and began to melt and retreat, depositing the rock and soil, once trapped within the ice, as terminal moraines. These terminal moraines can be found on Martha's Vineyard (USACE, 2009).

The geological deposits that make up the site consist of recent beach and marsh sediments, glacial deposits, interglacial deposits, and glacially deformed ancient coastal plain sediments. The island consists mostly of deposits from the last glacial stage, but in places consists of glacial or interglacial deposits as much as 300,000 years old (USACE, 2009). These deposits overlie solid bedrock and range from approximately 500 ft thick on the north shore of Martha's Vineyard to 900 ft thick on the south shore. The bedrock consists of metamorphic rocks, such as schist and gneiss, and igneous rocks (USACE, 2009).

2.3.6.3 Topography

The topography of the Tisbury Great Pond MRS is relatively flat with sand dunes, which ran in height from approximately 5 to 10 ft. Elevations range from sea level to approximately 3 ft above mean sea level (msl) near the southern coastline to approximately 15 ft above msl in the northern portion of the site. There is a barrier beach that separates Tisbury Great Pond (a brackish pond) from the Atlantic Ocean. On occasion, the barrier beach is breached by storm events. In addition, the Town Sewers breach the beach several times a year to hydraulically connect the pond to the ocean to allow the pond to discharge freshwater to the Atlantic Ocean and allow saltwater enter the pond. The breach closes naturally after each of these events. The breach locations started on the western edge of the pond and move eastward with each successive breach east of the previous one. The most recent breaches have cut through the dune on the eastern edge of the pond.

2.3.6.4 Soils

The soils at the MRS consist of beaches, Udipsamments, Carver loamy coarse sand, Riverhead sandy loam, and Eastchop loamy sand; and the low lying soils Barryland loamy sand and Pompton sandy loam (United States Department of Agriculture – Soil Conservation Service [USDA-SCS], 1986). Descriptions of the soils located at various locations within the MRS are provided below.

Soils at the barrier beach consist of beach areas and Udipsamments soils, which are found near the coast. Both soils consist of deep sand of various texture that have rapid to very rapid permeability. Due to the continuous washing and rewashing by waves, beach areas typically do not have plant cover. Most areas of Udipsamments will have a cover of grasses and shrubs. The beaches nearest the ocean are inundated twice daily by tides. The entire beach is generally flooded by spring tides and storm tides (USDA-SCS, 1986).

Soils located adjacent to Tisbury Great Pond primarily consist of Carver loamy coarse sand and Riverhead sandy loam, with a smaller area of Eastchop loamy sand located on the western shore of the pond. These soils are very deep and range from well to excessively drained. All three soils are found on outwash plains and consist of sandy loam, loamy sand, or loamy coarse sand over coarse sand. Permeability of these soils ranges from rapid to very rapid. The depth to seasonal high water table is greater than 6 ft below ground surface (bgs) (USDA-SCS, 1986).

Two smaller soil units, based on aerial extent, located within the MRA are the Barryland loamy sand and Pompton sandy loam. These soils are located along Thumb Cove and Tisbury Great Pond. These soils are very deep and are generally poorly drained. Both soils are found closed depressions, at the base of swales, in low areas that border ponds and swamps, and in drainageways. The Barryland and Pompton soils consist of sand and loamy sand, respectively. These soils have moderate to rapid permeability. The Barryland soil (located along Thumb Cove) has a seasonal high water table at or near ground surface in the fall, winter, and spring. Water is ponded in the surface in some areas. The Pompton soil (located along the Tisbury Great Pond) has a seasonal high water table at a depth of 1 to 2 ft bgs (USDA-SCS, 1986).

2.3.6.5 Surface Water Hydrology

Tisbury Great Pond is a salt-water pond approximately 735 acres in size and up to 20 feet deep that fills with fresh water runoff received from an 11,000 acre watershed. Several times a year, a channel is excavated to hydraulically connect the pond to the Atlantic Ocean, recharging the salinity and lowering the pond water level. The water quality of the pond is considered to be impaired due to low dissolved oxygen in deep water and elevated nitrogen levels. In addition to the planned openings, natural breaches occur as a result of storm events. Regardless of whether the breach is man-made or natural, it closes naturally after several days to several weeks. The man-made cuts progress west to east, and each cut is moved sequentially to the east. This action allows 3 to 4 ft of water to drain back to the ocean. The channel is opened on an "as needed" basis (USACE, 1999).

2.3.6.6 Groundwater Hydrology

Groundwater at the MRS occurs predominately in the unconsolidated and moderately consolidated glacial till material, which derive their water from local precipitation. Bedrock is much less permeable than the overlying sediments, commonly contains seawater, and is not considered to be part of the aquifers of Martha's Vineyard (United States Army Engineering Support Center, Huntsville [USAESCH], 2010).

Groundwater is encountered at the MRS at a depth ranging from 1 to 2 ft bgs. The water table generally mimics topography and is weakly influenced by tidal fluctuations. Groundwater quality studies indicate that salt water intrusion occurs along the coastline and to a lesser degree throughout the interior of the island. The shallow freshwater aquifer is underlain by brackish groundwater that is unsuitable for human consumption (USACE, 2009). Groundwater flow direction within the Tisbury Great Pond watershed generally trends to the south or toward the pond (Alion, 2008). Groundwater in Martha's Vineyard is primarily discharged directly to the ocean and surrounding bays (USACE, 2009).

In general, supplies of water for homes, cooling, and small businesses can be developed in most areas of outwash from wells that are 1.5 to 2 inches in diameter with 3 ft of screen set about 10 ft below the water table. According to the Massachusetts Department of Environmental Protection (MassDEP) Public Water Supply and Wellhead Protection Areas database, there are approximately 12 public water supply wells within 4 miles of Tisbury Great Pond (Alion, 2008).

2.3.6.7 Sensitive Species, Environments, and Environmental Resources

The current MRA includes four habitat types: 1) upland habitat; 2) inland water, 3) beach; and 4) ocean. These areas provide habitat to a variety of terrestrial plants, invertebrates, and wildlife as well as freshwater, estuarine, and marine organisms. The eastern portion of the MRA includes the Trustees of Reservations (TTOR) Long Point Reservation, an openspace area designated for conservation. The upland portions of the MRA are part of the sandplains habitat of Martha's Vineyard that originally supported a grassland or open woodland vegetation dominated by little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum virgatum*), Indian grass (*Sorghastrum nutans*), and other species of grasses, sedges, and forbs. Dominant trees of this habitat included scrub oak (*Quercus ilicifolia*) and pitch pine (*Pinus rigida*) (US Fish and Wildlife Service [USFWS], 1991). Various human disturbances, including agricultural and residential development, have modified or removed this natural vegetation type over some of the Investigation Area. Poison ivy (*Toxicodendron radicans*), beach plum (*Prunus maritima*), and bayberry (*Myrica pensylvanica*) are common throughout the area. Most of the upland area surrounding Tisbury Great Pond has been designated as Core Habitat and Critical Natural Habitat under BioMap2 (MDFW, 2012). The beach habitat includes large areas of unvegetated beach face backed by dunes supported by American beach grass (*Ammophila breviligulata*), seaside goldenrod (*Solidago sempervirens*), and other species adapted to coastal sand environments.

Tisbury Great Pond provides habitat for shellfish, including the American oyster (Crassostrea virginica) and soft-shell clam (Mya arenaria) (Howes et al., 2013). Oyster populations appear to be rebounding after a disease first detected in 1999 (Culbert. 2001) decimated the fishery. Restoration efforts have been led by the towns of West Tisbury and Chillmark, the Commonwealth of MA, and the Nature Conservancy. The pond also supports a blue-claw crab (Callinectes sapidus) fishery.

Tisbury Great Pond also supports a productive finfish community. Opening the pond allow alewives, an anadromous species, to enter and spawn in the upper estuary. Striped bass, bluefish, white perch, and American eel also occur in the pond. Recreational fishing is popular along the beach and the cut channel.

Historical aerial imagery and anecdotal information suggest that eelgrass was once well established in the pond. The pond currently supports only scattered patches of eelgrass. Loss of eelgrass is thought to be related to poor water quality caused by nutrient (nitrogen) enrichment (Howes, 2013).

The MRA is mapped as "Core Habitat" and "Critical Natural Landscape" by the Massachusetts Natural Heritage Endangered Species Program (MA NHESP) BioMap2 town report for Edgartown (MA NHESP, 2012). Core habitat identifies areas that are critical to long-term persistence of rare species in Massachusetts. Critical Natural Landscape encompasses habitat used by wide ranging species (e.g. tern), large areas of contiguous habitat, and buffer habitat. The MRA is within Core Habitat area 102 and Critical Natural Landscape area 45.

The MRA has been designated as a Priority Habitat of Rare Species and Estimated Habitats of Rare Wildlife in the Massachusetts Natural Heritage Atlas 13th Edition (effective October 1, 2008). Habitat alteration within areas mapped as Priority Habitats (PH) may result in a take of a state-listed species, and is subject to regulatory review by the Natural Heritage & Endangered Species Program. Priority habitat maps are based on known occurrence of rare species and habitat considerations. The MRA is mapped as PH 15. Based upon coordination with the USFWS, National Marine Fisheries Service, and MA NHESP; there are approximately 37 federal/state threatened, endangered, and/or special concern species that could be present on Martha's Vineyard (Table 2-3).

Table 2-3. Endangered, Threatened, and Special Concern Species
Tisbury Great Pond Munitions Response Area

Common Name	Scientific Name	State Status	Federal Status
Birds			
Common Tern	*Sterna hirundo*	Special Concern	--
Roseate Tern	*Sterna dougallii*	Endangered	Endangered
Least Tern	*Sterna antillarum*	Special Concern	--
Northern Harrier	*Circus syneus*	Threatened	--
Piping Plover	*Charadrius melodus*	Threatened	Threatened
Reptiles			
Green Sea Turtle	*Chelonia mydas*	Threatened	Threatened
Leatherback Sea Turtle	*Dermochelys coriacea*	Endangered	Endangered
Loggerhead Sea Turtle	*Caretta caretta*	Threatened	Threatened
Kemp's Ridley Sea Turtle	*Lepidochelys kempi*	Endangered	Endangered
Insects			
Northeastern beach tiger beetle	*Cicindela dorsalis dorsalis*	Endangered	Threatened
Chain dot Geometer	*Cingulia cateraria*	Special Concern	--
Coastal Heathland Cutworm	*Abagrotis nefascia*	Special Concern	--
Gerhard's Underwing Moth	*Catocala Herodias gerhardi*	Special Concern	--
Faded Grey Geometer	*Stenoporpia Polygrammaaria*	Threatened	--
Pine Barrens Zale	*Zale sp l nr lunifera*	Special Concern	--

Common Name	Scientific Name	State Status	Federal Status
Pink Sallow Moth	*Psectraglea carnosa*	Special Concern	--
Sandplain Euchaena	*Euchlaena madusaria*	Special Concern	--
Barrens Buckmoth	*Hemileuca maia*	Special Concern	--
Melsheimer’s Sack Bearer	*Cicinus Melsheimeri*	Threatened	--
Pine Barrens Lycia	*Lycia ypsilon*	Threatened	--
Coastal Swamp Metarranthis Moth	*Metarranthis pilosaria*	Special Concern	--
Slender Clearwig Sphinx Moth	*Henaris pilosaria*	Special Concern	--
Spartina Borer Moth	*Spartiniphagia inops*	Special Concern	--
Imperial Moth	*Eacles imperialis*	Threatened	--
Barrens Metarranthis Moth	*Metarranthis apiciaria*	Endangered	--
Comet Darner	*Anax longippes*	Special Concern	--
Purple Tiger Beetle	*Cicindela purpurea*	Endangered	--
Three-Lined Angle Moth	*Digrammia eremiata*	Threatened	--
Plants			
Sandplain gerardia	*Agalinus acuta*	Endangered	Endangered
Bristly Foxtail	*Setaria parviflora*	Special Concern	--
Bushy Rockrose	*Crocanthemum dumosum*	Special Concern	--
Purple Needlegrass	*Aristida purpurascens*	Threatened	--
Sandplain Flax	*Linum intercursum*	Special Concern	--
Saltpond Pennywort	*Hydrocotyle verticellata*	Threatened	--
Pygmyweed	*Tillacea aquatica*	Threatened	--
Sandplain Blue-eyed grass	*Sisinchium fuseatum*	Special Concern	--
Nantucket Shadbush	*Amelanchier nantuckensis*	Special Concern	--
Sea-Breach Knotweed	*Polygonum glaucum*	Special Concern	--

Note: This list was obtained from the RI Work Plan (UXB, 2011).
-- Status not listed

Table 2-4 summarizes the observed species found within the MRA. These include piping plover (*Charadrius melodus*) a federally threatened species which may utilize beach and nearby upland habitat, the federally endangered roseate tern (*Sterna dougallii*), the Northeastern beach tiger beetle (*Cicindela dorsalis dorsalis), the sandplain gerardia, a plant,* and four federally listed sea turtle species and blue crabs which may utilize nearshore ocean habitat. Sea turtles occur seasonally off the coast of Martha’s Vineyard from June through early November of any year. While they may occur near shore off Tisbury Great Pond, they are likely to occur in the offshore MRS only briefly as transients. State listed species include many insect and plant species which may utilize upland coastal sandplain or beach habitat.

Table 2-4. Observed Species within Tisbury Great Pond MRA

Species	Federal Threatened and Endangered Species?	Massachusetts Threatened and Endangered Species?	Found Within FUDS MRS?	Found On Martha's Vineyard?	Comment	Reference
Piping plover (Charadrius melodus)	Yes	Yes	Yes	Yes	Two piping plovers were observed by Biodiversity Works during RI fieldwork	Correspondence, Biodiversity Works, April 2011
Roseate Tern (Sterna dougallii**)**	Yes	Yes	Yes	Yes	MA NHESP has recorded nesting of protected tern species along the Tisbury Great Pond barrier beach to the west of Long Point to the western end on the private properties controlled by the Quansoo Beach Association	Personal communication, Tim Simmons, MA NHESP 5 (2010)
Common Tern (Sterna hirundo)	No	Yes	Yes	Yes	In 2010 a tern colony, Common and Least, were recorded nesting along the beach/dunes of Tisbury Great Pond barrier beach.	Chapter 7.0 Environmental Protection Plan, Final RI Work Plan (2011)
Least Tern (Sterna antillarum)	No	Yes	Yes	Yes		
Northeastern beach tiger beetle (Cicindela dorsalis)	Yes	Yes	Yes	Yes	The Northeastern Beach Tiger Beetle (NEBTB) occurs on the sandy beaches, washover areas and blowouts of the Tisbury Great Pond MRS.	Chapter 7.0 Environmental Protection Plan, Final RI Work Plan (2011)
Gerardia Sandplain (Agalinus acuta)	Yes	Yes	Yes	Yes	Sandplain gerardia has been located only at the Tisbury Great Pond MRS, east of Long Cove Pond.	USFWS Response Letter, September 27, 2010

2.3.6.8 Demographics

The MRA is located near the towns of Chilmark and West Tisbury, in the southwest portion of Martha's Vineyard, Massachusetts. According to the 2010 Census, census track 2004 has a population density of 33.6 people per square miles and there are 1,239 housing units within two miles of the investigation area. Due to seasonal occupancy, the population within the census tract may significantly increase. According to the Martha's Vineyard Chamber of Commerce, the population of Martha's Vineyard increases from 16,535 in non-summer months to more than 125,000 in the summer months (Martha's Vineyard Chamber of Commerce, 2012).

2.3.6.9 Current and Future Land Use

Currently, the site is owned by TTOR, the Commonwealth of Massachusetts (inland and coastal waters), and private landowners (Figure 2-6). The land is part of the Massachusetts Coastal Zone and Long Point Wildlife Refuge. When military use of the property ended, Tisbury Great Pond was developed into a shellfish harvest area. Today the site is a designated shellfish fisheries area and is actively harvested for oysters, clams, and fish. Private landowners own small portions of the property for recreational use. The majority of the barrier beach at the southern end of the pond is privately owned. It is anticipated that the future land use will remain the same.

2.3.6.10 Remedial Investigation Conclusions

The objective of the RI, to delineate the nature and extent of MEC and MCs impacted from historic training activities conducted at the Tisbury Great Pond MRA, was achieved. RI activities including geophysical surveying, MEC intrusive investigations, and environmental sampling for analysis of MCs was conducted within land, beach, inland water, and ocean sub-areas.

Key findings of the RI included:

- During the RI, 6 MEC items (practice bombs with spotting charges), 31 MD items and 254 non-MD items were identified.
    - The beach, inland water, and ocean near the "Cut" contained the highest concentration of MEC and MD items.
    - Three MEC items were identified within the northwest portion of Tisbury Great Pond (outside of the MRA boundary). The MEC items were all recovered in a single grid and consisted of three MK23s co-located in one hole. This fact coupled with the distance from the historic target and other MK23 finds indicates it is likely they were secondarily transported via human activity.
    - The land area east of Tisbury Great Pond contained one MEC item and no MD items. Considering the distance from the historic bombing target and that no other MEC or MD items were observed in the adjacent areas, it is unlikely that other MEC items are located in this area.
- Emergency Responses
    - MD items were identified in four instances on the beach near the "Cut," three on 23 February, three on 24 February, two on 26 February, and six on 13 July 2011.
    - An unknown bomb determined to be filled with high explosives by EOD was identified in August 2009 west of the current "Cut." Due to the mission of the EOD to render items safe by detonation (as opposed to perforating the items to

US Army Corps of Engineers

NOTES:
2009 Aerial Data Source:
MassGIS

UXB amec

FIGURE 2-6

Current Land Use - Tisbury Great Pond
Munitions Response Area, Martha's Vineyard, MA

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  - first determine is the items contain explosives) coupled with the large amount of explosives used by the EOD team, USACE has concluded that it is difficult to determine if an item was MD or MEC based on the resulting explosive during detonation.
  - One ordnance item was identified during an emergency response at the West Tisbury Great Pond "cut" on 20 August 2009. Due to high tide and strong current, the item was left in place.
- During the Transport Acoustic Transponder (Pinger) Survey a spotting charge simulant was transported laterally/parallel to the beach in near shore currents and 100-lb bomb simulants were identified at the location where they were placed but were buried under 8-inches of sand.
- MC Sampling
  - MC sampling indicated that human health screening criterion were not exceeded in any media.
  - Lead was identified at concentrations exceeding ecological screening criterion in surface and subsurface soil.
  - Lead and nickel were identified at concentrations exceeding ecological screening criterion in sediment in both investigation and background samples.
  - No high explosive compounds or their by-products were detected in soil; therefore, none of these compounds pose a potential risk to ecological receptors resources at this site.
  - None of the key metals (antimony, copper, lead, nickel, and zinc) occur in soil at levels that exceed Massachusetts Department of Environmental Protection (MADEP)-specified background concentrations; therefore, all are consistent with a condition of No Significant Risk based on the MCP Method I Standards.
  - Lead levels in surface soil exceeded the ecological soil screening levels for insectivorous birds; however, further evaluation of conservative assumptions indicated that the potential for risk from this metal is negligible.
  - Although the concentrations of lead and nickel in surface sediment from Tisbury Great Pond exceeded the USEPA Region 3 ecological screening levels for those metals, their potential for risk was found to be insignificant based on the 95% upper confidence level concentrations. In addition, background sediment concentrations also exceeded the USEPA Region 3 ecological screening levels for lead and nickel.
- Under current conditions, the land/beach area received a hazard level category of 1 in the MEC HA, indicating the highest potential explosive hazard conditions are present. This assessment was based upon the pre-RI discovery of an unknown high explosive bomb west of the current "Cut" location.

Based upon the RI results, it was recommended that no change be made to the MRA boundary established during the ASR Supplement (USACE, 2004). The boundary includes the extent of MEC determined through previous investigations and geophysical and intrusive investigation data. It was also recommended that Tisbury Great Pond MRA be subdivided into two MRSs, comprising the Tisbury Great Pond MRS (123 acres) and the Remaining Land and Water MRS (959 acres) (Figure 2-2). Based upon the information gathered from historical records, previous investigations, and RI results, a FS was recommended to evaluate future response action alternatives with regard to MEC hazards at the Tisbury great Pond. No further evaluation of MC is warranted.

No action was recommended for the remaining 959 acres, delineated as the Remaining Land and Water MRS, as no MEC have been confirmed within this area based on data and information collected to date for the FUDS.

3.0 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 has been 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 and are proposed by the state. In addition, the NCP, published in 40 CFR Part 300.400(g)(3), states that TBC criteria may be listed. TBC are local ordinances, unpromulgated criteria, advisories, or guidance that do not meet the definition of ARARs but that may assist in the development of remedial objectives.

ARARs are defined as follows:

- Applicable requirements - Those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.
- Relevant and appropriate requirements - Those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

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 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 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.

ARARs identified during the RI are evaluated and potentially eliminated during the FS and finalized prior to issuance of the Decision Document (DD) For a remedial alternatives to pass into the detailed analysis stage of the FS and thus become eligible for selection, it must comply with its ARARs or a waiver should be identified and the justification provided for invoking it. An alternative that cannot comply with ARARs, or for which a waiver cannot be justified, should be eliminated from consideration for further discussion as a potential alternative. Updates to ARARs are made as details of remedial alternatives become known. Thus, potential ARARs that are initially identified on a fairly broad basis, are refined to specific requirements during the subsequent stages of the remedial process, and are finalized upon signature of the DD.

Thirty-four potential ARARs for the Tisbury Great Pond MRS are being carried forward to this FS. No TBC criteria were identified. Primary consideration will be given to remedial alternatives that attain or exceed the requirements of its ARARs. ARARs will be evaluated for each alternative in Section 6.0, Detailed Analysis.

The following requirements have been identified as potential ARARs. Only the substantive portions of these provisions are applicable or relevant and appropriate. Permits, consultations and plans are not included:

40 CFR 264.601 establishes requirements under RCRA 40 CFR 264 subpart X applicable to operators of open burning or open detonation of explosive waste, including military munitions

and explosive wastes. Specifically, 40 CFR 264.601 requires 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 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.

16 U.S.C. §1538(a)(1)(B) with respect to any endangered species of fish or wildlife listed pursuant to Section 1538 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.

321 CMR *10.04(1)* ***Prohibitions. …, no person may take, possess, transport, export, process, sell or offer for sale, buy or offer to buy, nor shall a common or contract carrier knowingly transport or receive for shipment, any plant or animal or part thereof on the state list or federal list; provided, however, that ownership, sale, or purchase of real property on which such plant or animal occurs is not prohibited.***

Several requirements, though not ARARs in themselves, are important to understanding the extent and breadth of 10.04(1) under Massachusetts law and must be adhered to as these are mandatory provisions. These include 321 CMR 10.16(1), 10.17(1) and 10.90.

a. 10.16(1) ***Project Segmentation. Projects shall not be segmented or phased to evade or defer the review requirements of 321 CMR 10.13 and 10.18 through 10.23 or the eligibility requirements for an exemption under 321 CMR 10.14. For the purposes of 321 CMR 10.13, 10.14 and 10.18 through 10.23, the entirety of a proposed Project subject to review, including likely future expansions, shall be considered, and not separate phases or segments thereof. In determining whether two or more segments or components are in fact parts of one Project, all circumstances shall be considered, including but not limited to time interval between phases, whether the segments or components, taken together, constitute a part of a common plan or scheme, whether there is a commonality of ownership interests across two or more separate legal entities, whether and whether environmental impacts are separable. Ownership by different entities does not necessarily indicate that two segments or components are separate. …***

b. 10.17(1) ***Whether a Project or an Activity is within or encroaches upon a Priority Habitat shall be determined by consulting the Natural Heritage Atlas, which shall be the authoritative delineation of the boundaries of said Priority Habitat.***

c. 10.23 (see discussion below)

d. 10.90 (1) ***Introduction. The list in 321 CMR 10.90 contains the names of all species of plants and animals which have been determined to be Endangered, Threatened, or of Special Concern pursuant to M.G.L. c. 131A and 321 CMR 10.03.***

The substantive provisions of 321 CMR 10.23 as included below are potential ARAR in themselves (and also as an inherent exception to the prohibition in 321 CMR 10.04(1)). Since only the substantive portions of this provision are applicable or relevant and appropriate, permits, consultations, and plans are not included. As such, where it says "permit" in Section (1) and (7),below, that should be read to mean "allow." In Section (2)(c) and (3), below, "plan" means "actions." In Section (2) the following phrase "Director may issue a conservation and management permit" is understood to mean "the taking is allowed." Further, throughout 321 CMR 10.23 "Applicant" is recognized as the USACE.

(1) … permit the Taking of a State-listed Species for conservation or management purposes provided there is a long-term Net Benefit to the conservation of the impacted species. …

(2) Except as provided in 321 CMR 10.23(6) below, if … the applicant … has avoided, minimized and mitigated impacts to State-listed Species consistent with the following performance standards, … the Director may issue a conservation and management permit provided:

(a) The applicant has adequately assessed alternatives to both temporary and permanent impacts to State-listed Species;

(b) An insignificant portion of the local population would be impacted by the Project or Activity, and;

(c) The applicant agrees to carry out … conservation and management plan … that provides a long-term Net Benefit to the conservation of the State-listed Species … and shall be carried out by the applicant.

(3) Except as provided in 321 CMR 10.23(6) below, if a conservation and management … applicant is unable to demonstrate the long-term Net Benefit performance standard on the project site and the applicant has made every reasonable effort to avoid, minimize and mitigate impacts to the State-listed Species on site, then the conservation and management plan … meet the long-term Net Benefit performance standard by providing for financial or in-kind contributions toward the development and/or the implementation of an off-site conservation recovery and protection plan for the impacted species.

(4) …

(5) …

(6) Projects or Activities Eligible for Coverage … when the Division has issued a Conservation Plan
(a) …
(b) …

1. The applicant shall implement and comply with species-specific development standards or best management practices, or both, applicable to the geographic area and the species habitat that would be impacted by the Project or Activity. Notwithstanding 321 CMR 10.23(2), the proponent is not required to provide an alternatives analysis or to demonstrate that an insignificant portion of the local population of the affected State-listed Species of Special Concern would be impacted by the Project or Activity.

2. The applicant shall provide off-site mitigation, or a combination of on-site and off-site mitigation subject to the Division's approval, that achieves the long-term Net Benefit standard in 321 CMR 10.23(1), as determined by the Division. Any off-site mitigation provided by the applicant in the form of a financial contribution will be used to fund habitat management or the protection of land or other appropriate mitigation within one or more conservation protection zones established in the conservation plan issued by the Division pursuant to 321 CMR 10.26. The amount of any such off-site mitigation payment will be determined by the Division based on a formula set forth in written guidance that, at a minimum, considers the area of impact on the on-site habitat of the affected State-listed Species of Special Concern and the land values within one or more of the conservation protection zones. Notwithstanding 321 CMR 10.23(3), the applicant may propose off-site mitigation without a showing that the applicant has made every reasonable effort to avoid, minimize and mitigate impacts to the affected State-listed Species of Special Concern on-site.

3. …

(c) …

(7) General Mitigation Standards applicable to Individual and General Conservation and Management Permits issued by the Director.

(a) … generally apply the following areal habitat mitigation ratios, based on the category of State-listed Species:

1. Endangered Species: 1:3 (i.e., protection of three times the amount of areal habitat of the affected Endangered Species that is impacted by the Project or Activity);

2. Threatened Species: 1:2 (i.e., protection of two times the amount of areal habitat of the affected Threatened Species that is impacted by the Project or Activity).

3. Special Concern Species: 1:1.5 (i.e., protection of one and one half times the amount of areal habitat of the affected Species of Special Concern that is impacted by the Project or Activity).

(b) … A project proponent may also request in writing that the Director apply an alternative mitigation ratio or alternative mitigation approach to the Project or Activity. Any such request shall explain why an alternative mitigation ratio or alternative mitigation approach is

appropriate, addressing the relevant factors in 321 CMR 10.23(7)(b)1.-5. below. In determining whether an alternative mitigation ratio or alternative mitigation approach is appropriate, the Director will consider factors that include but are not limited to:

1. the size and configuration of the habitat impact;

2. the threats to the affected State-listed Species posed by uses or activities located adjacent or in close proximity to the Project or Activity that is the subject of the conservation and management permit;

3. the size, configuration and quality of the habitat proposed to be protected by the applicant;
4. the population density of the affected State-listed Species; and

5. the habitat management and research needs associated with the affected State-listed Species.
(c) …

310 CMR 9.40 (2)(b) (1st sentence) – Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate.

The design and timing of dredging and dredged material disposal activity shall be such as to minimize adverse impacts on shellfish beds, fishery resource areas, and submerged aquatic vegetation.

310 CMR 9.40 (3)(b) (1st sentence) – Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate based on state representations that this provision is not limiting the scope of the remediation, but rather requires the use of best management practices to minimize "slumping."

The shoreward extent of dredging shall be a sufficient distance from the edge of adjacent marshes to avoid slumping.

310 CMR 10.25 (5) Land under the Ocean

Projects … which affect nearshore areas of land under the ocean shall not cause adverse effects by altering the bottom topography so as to increase storm damage or erosion of coastal beaches, coastal banks, coastal dunes, or salt marshes.

310 CMR 10.25 (6) Land under the Ocean

Projects … which affect land under the ocean shall if water-dependent be designed and constructed, using best available measures, so as to minimize adverse effects, …

310 CMR 10.25 (7) Land under the Ocean

Notwithstanding the provisions of 310 CMR 10.25(3) through (6), no project may … have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.27 (3) Coastal Beaches

Any project on a coastal beach shall not have an adverse effect by increasing erosion, decreasing the volume or changing the form of any such coastal beach or an adjacent or downdrift coastal beach.

310 CMR 10.27 (6) Coastal Beaches

In addition to complying with the requirements of 310 CMR 10.27(3) and (4), a project on

a tidal flat shall if water-dependent be designed and constructed, using best available measures, so as to minimize adverse effects, …

310 CMR 10.27 (7) Coastal Beaches

Notwithstanding the provisions of 310 CMR 10.27(3) through (6), no project may … have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.28 (3) Coastal Dunes

Any alteration of, or structure on, a coastal dune or within 100 feet of a coastal dune shall not have an adverse effect on the coastal dune by:

(a) affecting the ability of waves to remove sand from the dune;

(b) disturbing the vegetative cover so as to destabilize the dune;

(c) causing any modification of the dune form that would increase the potential for storm or flood damage;

(d) interfering with the landward or lateral movement of the dune;

(e) causing removal of sand from the dune artificially; or

(f) interfering with mapped or otherwise identified bird nesting habitat

310 CMR 10.28 (6) Coastal Dunes

Notwithstanding the provisions of 310 CMR 10.28(3) through (5), no project may … have any adverse effect on specified habitat sites of Rare Species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.29 Barrier Beaches – Though this provision does not meet the definition of an ARAR, we are on notice that the other ARAR requirements found in 310 CMR 10 also apply to barrier beaches.

310 CMR 10.33 (3) Land under Salt Ponds

Any project on land under a salt pond, on lands within 100 feet of the mean high water line of a salt pond, or on land under a body of water adjacent to a salt pond shall not have an adverse effect on the marine fisheries or wildlife habitat of such a salt pond caused by:

(a) alterations of water circulation;

(b) alterations in the distribution of sediment grain size and the relief or elevation of the bottom topography;

(c) modifications in the flow of fresh and/or salt water;

(d) alterations in the productivity of plants, or

(e) alterations in water quality, including, but not limited to, other than normal fluctuations in the level of dissolved oxygen, nutrients, temperature or turbidity, or the addition of pollutants.

310 CMR 10.33 (5) Land under Salt Ponds

Notwithstanding the provisions of 310 CMR 10.33(3) and (4), no project may … have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.34 (4) Land Containing Shellfish

(4) Except as provided in 310 CMR 10.34(5), any project on land containing shellfish shall not adversely affect such land or marine fisheries by a change in the productivity of such land caused by:

(a) alterations of water circulation;

(b) alterations in relief elevation;

(c) the compacting of sediment by vehicular traffic;

(d) alterations in the distribution of sediment grain size;

(e) alterations in natural drainage from adjacent land; or

(f) changes in water quality, including, but not limited to, other than natural fluctuations in the levels of salinity, dissolved oxygen, nutrients, temperature or turbidity, or the addition of pollutants.

310 CMR 10.34(5) Land Containing Shellfish

(5) Notwithstanding the provisions of 310 CMR 10.34(4), projects which temporarily have an adverse effect on shellfish productivity but which do not permanently destroy the habitat may … [be conducted] if the land containing shellfish can and will be returned substantially to its former productivity in less than one year from the commencement of work.

310 CMR 10.34 (8) Land Containing Shellfish

(8) Notwithstanding the provisions of 310 CMR 10.34(4) through (7), no project may ⋯ have any adverse effect on specified habitat of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.35(3) Banks of or Land under the Ocean, Ponds, Streams, Rivers, Lakes or Creeks that Underlie an Anadromous/Catadromous Fish Run

(3) Any project on such land or bank shall not have an adverse effect on the anadromous or catadromous fish run by:

(a) impeding or obstructing the migration of the fish, unless DMF has determined that such impeding or obstructing is acceptable, pursuant to its authority under M.G.L. c. 130, § 19;

(b) changing the volume or rate of flow of water within the fish run; or

(c) impairing the capacity of spawning or nursery habitats necessary to sustain the various life stages of the fish.

310 CMR 10.35(4) Banks of or Land under the Ocean, Ponds, Streams, Rivers, Lakes or Creeks that Underlie an Anadromous/Catadromous Fish Run

(4) … dredging, disposal of Dredged Material or filling in a fish run shall be prohibited between March 15th and June 15th in any year.

310 CMR 10.35(5) Banks of or Land under the Ocean, Ponds, Streams, Rivers, Lakes or Creeks that Underlie an Anadromous/Catadromous Fish Run

(5) Notwithstanding the provisions of 310 CMR 10.35(3), no project may … have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

310 CMR 10.37 5th paragraph, 1st sentence, Estimated Habitats of Rare Wildlife (for Coastal Wetlands)

… if a proposed project is found by the issuing authority to alter a resource area which is part of the habitat of a state-listed species, such project shall not … have any short or long term adverse effects on the habitat of the local population of that species.

310 CMR 10.55 (4)(a) Bordering Vegetated Wetlands (Wet Meadows, Marshes, Swamps and Bogs)

Where the presumption set forth in 310 CMR 10.55(3) is not overcome, any proposed work in a Bordering Vegetated Wetland shall not destroy or otherwise impair any portion of said area.

310 CMR 10.55 (4)(b) Bordering Vegetated Wetlands (Wet Meadows, Marshes, Swamps and Bogs)

Notwithstanding the provisions of 310 CMR 10.55(4)(a), the issuing authority may issue an Order of Conditions permitting work which results in the loss of up to 5000 square feet of Bordering Vegetated Wetland when said area is replaced in accordance with the following general conditions and any additional, specific conditions the issuing authority deems necessary to ensure that the replacement area will function in a manner similar to the area that will be lost:

1. the surface of the replacement area to be created ("the replacement area") shall be equal to that of the area that will be lost ("the lost area");

2. the ground water and surface elevation of the replacement area shall be approximately equal to that of the lost area;

3. The overall horizontal configuration and location of the replacement area with respect to the bank shall be similar to that of the lost area;

4. the replacement area shall have an unrestricted hydraulic connection to the same water body or waterway associated with the lost area;

5. the replacement area shall be located within the same general area of the water body or reach of the waterway as the lost area;

6. at least 75% of the surface of the replacement area shall be reestablished with indigenous wetland plant species within two growing seasons, and prior to said vegetative reestablishment any exposed soil in the replacement area shall be temporarily stabilized to prevent erosion in accordance with standard U.S. Soil Conservation Service methods; and

7. the replacement area shall be provided in a manner which is consistent with all other General Performance Standards for each resource area in Part III of 310 CMR 10.00.

310 CMR 10.55 (4)(d) Bordering Vegetated Wetlands (Wet Meadows, Marshes, Swamps and Bogs)

Notwithstanding the provisions of 310 CMR 10.55(4)(a),(b) and (c), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.59.

314 CMR 9.06 (2)(1st sentence) Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate.

No discharge of dredged or fill material [in waters of the United States within the Commonwealth can occur] … unless appropriate and practicable steps have been taken which will avoid and minimize potential adverse impacts to the bordering or isolated vegetated wetlands, land under water or ocean, or the intertidal zone.

314 CMR 9.07 (1)(a)(1st sentence) Though this project does not constitute dredging and, therefore, this requirement is not applicable, this provision was deemed relevant and appropriate.

No dredging shall … occur unless appropriate and practicable steps have been taken which will first avoid, and if avoidance is not possible then minimize, or if neither avoidance or minimization are possible, then mitigate, potential adverse impacts to land under water or ocean, intertidal zone and special aquatic sites.

4.0 Identification and Screening of Technologies

This section establishes the RAO for the FS and identifies general response actions and potential MEC detection and removal technologies for the Tisbury Great Pond 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 5) and are further evaluated in the Detailed Analysis of Alternatives (Section 6) of this report.

4.1 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 goals. 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 (US Army Environmental Command, 2009). The RAO for the Tisbury Great Pond MRS addresses the overall goal of managing risk and protecting human health based on the results of the RI.

MEC were found during the RI field work and the revised MEC conceptual site model (CSM) identifies potential exposure pathways for all receptors with access to the Tisbury Great Pond MRS based on current and future anticipated land use. Within the land, ocean and inland water portions of the investigation area, MEC was found between 6 inches and 2 feet below ground surface (bgs). In the dunes, MEC was found at a depth of 3 feet below the base of the dune. Workers, visitors, and recreational users may encounter MEC while engaging in surface and intrusive activities. Therefore, the RAO for the MRS is:

- to protect recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure within and below the dunes and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion.

4.2 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 Tisbury Great Pond MRS:

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

- **Subsurface Remedial Action –** MEC can be detected and removed from below the ground surface. Alternatives for clearance include technologies for detection, positioning for the detection technologies, removal, and disposal.

4.3 Evaluation of Technologies

Various technologies and approaches exist to manage risks associated with MEC. Risk management can be accomplished through a variety of engineering or LUC components (i.e., institutional controls [ICs]) designed for implementation based on 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 Tisbury Great Pond MRS.

4.3.1 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.

4.3.1.1 Effectiveness

In accordance with EPA guidance (EPA, 1988), technologies or alternatives that have been identified should be evaluated further based on their effectiveness relative to other processes within the same technology or alternative type. This evaluation should focus on: (1) the potential effectiveness of technology or 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 or alternative is with respect to the MEC and conditions at the site.

4.3.1.2 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 or alternative options with respect to conditions at a specific site. Technical feasibility refers to the ability to construct and reliably operate, a technology or alternative option until a remedial action is complete. It also includes operation, maintenance, replacement, and monitoring of technical components of a technology or 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 or 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 or alternative but will not necessarily eliminate a technology or alternative from consideration (EPA, 1988).

4.3.1.3 Cost

Typically, technologies and alternatives are defined sufficiently prior to screening so that estimates of cost are available for developing comparisons among technologies and alternatives. However, because uncertainties associated with the definition of technologies and alternatives often remain, it may not be practicable to define the costs of technologies and 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 and alternatives with relative accuracy so that cost decisions among technologies and alternatives will be sustained as the accuracy of cost estimates improves beyond the screening process (EPA, 1988).

4.3.2 Land Use Controls

In accordance with the 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, such as fences or signs. The legal mechanisms are generally the same as those used for ICs as discussed in the NCP. 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, which can also be ICs, 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 MRS referred to the USACE guidance Engineering Pamphlet (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 or warnings, or administrative mechanisms such as construction support or educational components to restrict access 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 and 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 and 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 Tisbury Great Pond MRS in Table 4-1.

To facilitate development and evaluation of LUC options and viability for use at the Tisbury Great Pond MRS, an Institutional Analysis was performed for the MRS to support the FS and is provided as Appendix B.

4.3.3 MEC Detection

Detection technologies include those methods and instruments used to locate surface and subsurface MEC 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 MEC properties such as the depth and size of the suspected items, and the physical characteristics of the Tisbury Great Pond MRS (i.e., soil type, topography, vegetation, and local geology, sediment littoral characteristics and underwater topography).

Table 4-1. Land Use Controls

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at 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**: Costs are variable based on level of effort.	Administrative	The 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 non-DoD land included within the MRS boundaries.
Physical Mechanisms: Engineered barriers or physical structures designed to prevent access such as fencing or guard posts. Physical mechanisms also include the installation or construction of signs designed to provide information on the potential hazards at a site.	**Low**: Fencing or guards to restrict access is not anticipated to be very effective at the MRS as the delineated MEC is present in the subsurface and much of the MRS is recreational areas intended for public use, and installing barriers around these is impracticable due to their location on or adjacent to open water. **High:** The installation of signs could be very effective at the MRS in warning users of potential risks due to remaining MEC.	**Easy**: Although fencing and guards are would be impracticable at the MRS, the installation of signs would be relatively easy to implement.	**Low**: Low costs associated with physical mechanisms	Signs	Long-term effectiveness is expected to require periodic inspection and sign maintenance within the MRS.	**High/Retained:** The installation of signs containing information on the potential remaining hazards at the MRS could be used to guide behavior and reduce the probability of MEC being handled.
Administrative Mechanisms: Educational programs including public information dissemination and advisories (e.g., written protocol or guidance, brochures, fact sheets, training programs, etc.,); management through permitting requirements.	**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 both MRS.	**Easy**: Easily implementable for MRS 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. Based on data collected through the RI for the MRS, the nature and extent of munitions-related hazards has been fully characterized.	**Low**: Costs are variable based on level of effort.	Administrative to produce informational materials and provide training materials.	Landowners are aware of the history of the MRS, 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.	**High/Retained:** Institutional controls consisting of education programs tailored to the individuals most likely to be exposed to MEC present within the MRS could be used to guide behavior and reduce the probability of MEC being handled by unqualified individuals.

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On land, there are two basic forms of MEC detection. The first, visual searching, has been successfully used at a number of sites where MEC is located on the ground surface. When performing a visual search of a site, the area to be searched is typically divided into 5-foot lanes that are systematically inspected for MEC. A metal detector is sometimes used to supplement the visual search in areas where ground vegetation may conceal surface munitions. Typically, any MEC 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 MEC and is integrated with the equipment and methods used for location positioning. Each piece of equipment has its own inherent advantages and disadvantages based on its operating characteristics. Thus, selecting the appropriate type of geophysical instrument is critical to the survey success. The instruments designed to locate subsurface MEC include magnetometers and electromagnetic instruments. Positioning technologies include various equipment and instruments that establish geo-referenced positions for subsurface anomalies detected using MEC detection technologies. The viability of positioning technologies is affected by site conditions, including terrain, tree canopy, and vegetation density.

Underwater detection technologies include geophysical sensors, bathymetric technologies, and sediment bottom imaging technologies. Underwater geophysical electromagnetic induction (EMI) and magnetometer technologies are largely the same as those used for land investigations; however, underwater investigations present more challenges. Geophysical sensors unique to the marine environment include sonar technologies. While sonar technologies are primarily used for bathymetric and sediment bottom imaging, there are some that can also aid in MEC detection.

The MEC detection technologies and positioning technologies are described and screened against the three criteria of effectiveness, implementability, and cost for use at the Tisbury Great Pond MRS in Table 4-2 and Table 4-3, respectively. Site-specific performance results for equipment tested and employed during the RI at the MRS is incorporated into the technology screening to the extent possible.

4.3.4 MEC Clearance

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

Potential subsurface MEC identified by a geophysical survey or other detection methods requires excavation for 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 MRSs. 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 mitigation techniques 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. Removal technologies applicable to clearance of MEC delineated at the Tisbury Great Pond MRS are described in Table 4-4 and are screened against the three criteria of effectiveness, implementability, and cost.

4.3.5 MEC Disposal

Munitions response procedures that would be followed during a clearance will require provisions to handle MEC. Table 4-5 provides a description and evaluation of MEC disposal technology options including blow-in-place (BIP), consolidated shot, laser initiation, and contained detonation chambers.

Table 4-2. Detection Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/Status of Retention
Visual Searching	**Low:** Effective for surface clearance in open areas with little ground cover. However, no surface MEC was identified during the RI. 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**	NA	Typically supported with magnetometer or metal detectors	**Low/Not Retained:** Visual detection of MEC as a standalone technology would not be effective since the risk for exposure is subsurface.
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.	**Low:** Flux-gate magnetometers have been used as the primary detector in traditional mag & dig operations. There is a high industry familiarization. However, this technology only detects ferrous objects, and any potential non-ferrous items would remain onsite (AN-MK5s).	**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.	**Moderate:** A number of flux-gate magnetometers have a low cost for purchase and operation compared to other detection systems. However, labor costs can be significant.	Schonstedt GA-52Cx Schonstedt GA-72Cd Foerster FEREX 4.032 Schonstedt GAU-30 Vallon VXV4	Analog output not usually co-registered with navigational data.	**Low/ Not Retained:** Magnetometers only detect ferrous items and would are not effective in detecting non-ferrous items (such as zinc MK-5s) potentially located within the MRS.
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.	**moderate**: Proton precession systems have greater sensitivitiesthans flux-gate systems, but with a relatively slow sampling rate. There is a high industry familiarization. Detects ferrous objects only.	**Low**: Systems are similar to flux-gate systems in terms of operation and support. Generally heavier and require 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. Proton precession systems often acquire digital data.	Geometrics G-856AX GEM Systems GSM-19T Fishers Proton 4		**Low/Not Retained:** Proton precession systems are not viable options as a standalone detection system at the MRS because of low effectiveness.
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).	**Low:** This is the industry standard technology to detect MEC using magnetic data analysis. There is a high industry familiarization. However, this technology only detects ferrous objects, and any potential non-ferrous items would remain onsite (AN-MK5s).	**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. They are sensitive enough that correction for heading error should be made. Can be used in most traversable terrain. Widely available from a variety of sources. Processing and interpretation requires trained specialists. 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. Lower costs in labor can be realized when using arrays of multiple detector sensors.	Geometrics G-858 GEM Systems GSMP-40 Scientrex Smart Mag Geometrics G-882/881 Marine	Digital signal should be co-registered with navigational data for best results.	**Low/ Not Retained:** Magnetometers only detect ferrous items and would are not effective in detecting non-ferrous items.

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at 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.	**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 higher purchase cost compared to other technologies. Lower costs can be realized when using arrays of multiple detector sensors which reduces labor time.	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 Battelle TEM-8	Digital signal should be co-registered with navigational data for best results.	**High/Retained:** This technology was proven effective within the MRS during the RI and was relatively easy to implement. The technology is viable in most environments but has not been demonstrated within the high energy environment associated with the nearshore currents at this location.
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 of interest. This provides the necessary information for analysis and classification of hazardous and non-hazardous items.	**Low :** 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. The MEC and MD found during the RI were non-fragmenting itemsThe amount of non-MD found during the RI was approximately 10% of the total number of MEC. MD and non-MD items. Therefore, the cost effectiveness of using advanced classification to differentiate between MEC, MD and non-MD at this site is low.	**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 heavily vegetated 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.	**High:** Use of the advanced systems often represents additional surveying and processing costs, which may be offset by the decrease in the intrusive investigation costs. In addition, the cost benefits advanced classification typically brings will not be seen at this site since the amount of non-MD found during the RI was approximately 10% of the total number of EM anomalies.	ALLTEM Berkeley UXO Discriminator (BUD) BUD Handheld Geometrics MetalMapper (MM) Man Portable Vector (MPV)TEMTADS TEMTADS 2x2	Sensors have limited industry availability. Requires advanced training for operation, data processing, and analysis.	**Low /Not Retained:** The amount of non-MD found during the RI was approximately 10% of the total number of anomalies. Since most of the anomalies excavated were MEC or MD, a large cost savings for not digging the non-MD would not be realized.
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. Detects both ferrous and non-ferrous metallic objects.	**Easy-Moderate:** 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. Underwater use requires divers that are trained in the use of FDEMI technology. Difficult to use in deeper water since diver is required.	**Low:** 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 Minelabs F3 (UXO and Compact versions) Geophex GEM 3 Apex Max-Min Ceia CMD	Underwater analog output not usually co-registered with navigational data. Digital output should be co-registered with navigational data	**Moderate – High/Retained:** FDEMI detects all metals, instead of only ferrous items. The White's All-Metals Detector was proven effective during the RI at the MRS.

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/Status of Retention
Sub Audio Magnetics: Sub-audio megnetics 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, no proven track record, and 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:** Initial purchase price is high. Labor costs can be reduced when using a towed array platform. Limited availability.	MSEMS (man-portable EM61-Mk2 & G-822) VSEMS (vehicular EM61-Mk2 & G-822) USEMS (underwater) EM61-Mk2 & G-822)	Only available from a few sources.	**Moderate/Retained:** USEMS is currently available from USAESCH.
Airborne Synthetic Aperture Radar: 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)	Typically not applied to detect MEC.	**Low/Not Retained:** Low effectiveness in subsurface clearance activities.
Airborne Laser and Infrared Sensors: Infrared sensors 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 possess different heat capacities than the surrounding soil, and this temperature difference 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	Typically not applied to detect MEC.	**Low/Not Retained:** Difficult to implement and not readily available equipment (only available from a few sources).
Synthetic Aperture Sonar: SAS uses multiple pulses to create a large synthetic array. SAS uses a small sonar array to synthesize a much larger array. SAS uses a lower operating frequencies, increasing the range of the sonar signal without affecting the performance. SAS systems also have a wider field of view, resulting in a larger angular response from objects.	**Moderate**: SAS technology is still relatively new. Munitions detection capability versus proud targets is promising, but limited demonstrations. Low-frequency prototype SAS has demonstrated detection of partially buried objects.	**Moderate:** Synthetic aperture sonar moves sonar along a line and illuminates the same spot on the seafloor with several pings.	**Moderate**	Kongsberg HISAS 1030	Relatively new and not widely used.	**Low/Not Retained:** Effectiveness as detection technology is not yet proven.
BOSS: BOSS is wideband sonar that generates three-dimensional imagery of buried, partially buried, and proud targets. It is a type of SAS system that uses hydrophone receiver arrays to transmit an omnidirectional acoustic pulse and to record the energy backscatter from both the sediment surface and sediment layers.	**Moderate**: Known systems are still experimental; currently demonstrated detection capabilities show very consistent detection through 30 cm of sand. Classification capabilities unknown.	**Moderate:** BOSS generates images of objects buried in underwater sediments.	**High:**	CHIRP Lab SAS 40 Channel CHIRP Lab 252 Channel	Not widely used and validation studies have been performed.	**Low/Not Retained:** Effectiveness as detection technology is not yet proven.

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Table 4-3. Positioning Technologies

Technology	*Effectiveness*	*Implementability*	*Cost*	*Representative Systems*	*Notes*	*Viability at 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. Commonly achieves accuracy to a few centimeters, but degrades when minimum satellites are available.	**Easy**: Easy to operate and set up. 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.	**Moderate**: Requires rover and base station units. Survey control points required for high accuracy results.	Leica GPS 1200 Trimble GeoXT/XH?R6/R8/R10/ Thales Ashtech Series 6500 May be paired with Ultra Short Baseline acoustic positioning for underwater towed sensors	Recommended in open areas.	**High/Retained:** Was used duering the RI in the Tisbury Great Pond MRS effectively.
Robotic Total Station: Robotic Total Station 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.	**High**: Effective in open areas for both digital mapping and reacquiring anomalies. Effective around buildings and sparse trees. Commonly achieves accuracy to a few centimeters.	**Difficult**: Relatively easy to operate with trained personnel. Requires existing control and must maintain constant line of sight between single-point to roving prism. Minor impacts to cultural or natural resources based on clearing of areas for high quality data collection.	**Moderate**: 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/S6/VX/IS	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). Integrated Systems (IS) combine DGPS and RTS for use in highly diverse terraines.	**Moderate/Not Retained:** This technology is more difficult to implement than DGPS and requires constant line of site between single-point and roving prism. .
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).	**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 - Difficult**: Application requires a constant pace and detailed field notes. Can be used anywhere, with varying degrees of complexity in the operational setup. Requires "back end" data processing.	**Moderate**: Minimal direct costs associated with this method but it is labor intensive.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:** This method is more difficult to implement accurately than other methods, such as DGPS.
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. Requires detailed field notes and setup times can be lengthy. Can be used anywhere, with varying degrees of complexity in the operational setup. Requires "back end" data processing.	**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:** 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.	**High**: Underwater acoustical systems determine the position of a vehicle or diver by acoustically measuring the distance from a vehicle or diver interrogator to three or more seafloor deployed baseline transponders. These techniques result in very high positioning accuracy and position stability that is independent of water depth. It can reach a few centimeters accuracy. Accuracy on land is better than 15 cm.	**Difficult**: Difficult to set up and setup requirements are complex. (However, more easily set up and used by trained personnel.)	**High**: Lengthy setup time can be reduced by using trained personnel. Requires more than one operator.	Long-baseline (LBL) systems Ultra-short-baseline (USBL) systems Short-baseline (SBL) systems USRADs		**Low/Not Retained**: This technology is difficult to implement without trained and experienced operators.

Technology	*Effectiveness*	*Implementability*	*Cost*	*Representative Systems*	*Notes*	*Viability at MRS/Status of Retention*
Jackstays: Jackstay is an underwater grid system. Accurate positioning if the corners are easily done. A line (moveable) is attached to lines connected to the corners. The divers search along the movable line changing its position after each pass. When a diver finds a suspect items, a float is released to mark the positions. The surface support boat then marks the float with GPS.	**Highly effective:** Once set up, this system is effective underwater, especially in shallower depths. The effectiveness of jack stays can be dependent on currents and waves. However, the inland water portion of the MRS is relatively stable and currents and waves are not anticipated to inhibit the use of jackstays.	**Easy to Moderate:** This technology can be easily implemented underwater at shallower depth. The set up is sometimes tedious depending on how rough the water is.	**Moderate:** Since this technology requires both divers and support crew, it can be moderately expensive in field labor. However, the equipment is low in cost.		Requires trained UXO divers and boat support crew.	**High/Retained:** This technology is proven and is highly effective underwater where visibility is limited.

Table 4-4. Removal Technology

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at MRS/ Status of Retention
Hand Excavation: Technique includes digging individual anomalies using commonly available hand tools.	**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.	**Moderate**: Is the standard by which all others are measured.	Probe, trowel, shovel, pick axe.	Locally available and easily replaced tools.	**High/Retained:** This technology was successfully used during the RI and the depth at which MEC were detected during the RI are suitable for this technology.
Mechanical Excavation of Individual Anomalies: This method uses commonly available mechanical excavating equipment to support hand excavations.	**High**: Used in conjunction with hand excavation when soil is too hard, excavation depths are deep and 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.	**Moderate**: Equipment can be rented, is easy to operate, and allows excavation of anomalies in hard soil. Mobilization and use of equipment within the water portions of the MRS will require a boat.	**Moderate**:	Tracked mini-excavator or wheeled backhoe. Multiple manufacturers. Excavator with floatation tracks such as a marsh buggy,		**Moderate / Retained:** For deep subsurface anomalies not easily accessible by hand excavation. Would be effective at digging anomalies within water and will minimize diver time spent hand digging.
Mass Excavation and Sifting: Armored excavation and transportation equipment to protect the operator and equipment from unintentional detonation. Once soil has been excavated and transported to the processing area, it is then processed through a series of screening devices and conveyors to segregate MEC from soil.	**High**: Process works very well in heavily contaminated areas and in sandy environments. 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. Only feasible for the dunes within the MRS. Restoration required for disturbed areas. 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 has the added expense of high maintenance and restoration costs.	Many brands of heavy earth moving equipment, including excavators, off-road dump trucks, and front-end loaders. Trommel, shaker, rotary screen from varying manufacturers.	Can be rented and armor can be installed, and equipment delivered almost anywhere. Significant maintenance costs.	**High/ Retained:** Since the majority of MEC is anticipated to remain in the dunes, mass excavation and sifting of the dunes are viable options.
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 MEC and surface debris, but the size of MEC 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.	**Low/Not Retained:** Primarily used in conjunction with mass excavation and sifting operations. The amount of MEC at the MRS and the relatively large area does not require mass excavation.
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 the heavily vegetated areas within the MRS. 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 MRS because of low effectiveness and difficult implementation.

Table 4-5. MEC Disposal Technologies

Technology	Effectiveness	Implementability	Cost	Representative Systems	Notes	Viability at 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.	**High:** Each MEC item is individually destroyed with subsequent results individually verified using quality assurance and quality control. BIP yields unconfined releases of MC and MD, which can be restricted using mitigation techniques.	**Moderate to Easy:** Field-proven techniques, transportable tools, and equipment; suited to most environments. Public exposure can limit viability of this option. Mitigation techniques 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. Mitigation techniques may limit damages to these resources.	**Medium:** Manpower intensive. Costs increase in areas of higher population densities or where public access must be monitored and controlled. .	Electric demolition procedures, non-electric demolition procedures.	Disposition of resultant waste streams must be addressed in BIP operations planning.	**High/Retained:** Used for items that are deemed unsafe to move. Technology has been proven effective in similar field conditions.
Consolidated Shots: Consolidated detonations are the collection, configuration, and subsequent destruction by explosive detonation of MEC for which the risk of movement has been determined to be acceptable.	**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 mitigation techniques.. 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 and more mitigation.. However, the common location for detonation and ability to schedule events enables better control and management of impacts to the public. Most approved mitigation techniques. are not completely effective or 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.	**Medium/Retained:** Only used for items that are deemed safe to move. Requires an increase in explosive weight over what would be used for a single explosive demolition shot. Proven technology for addressing MEC and allow for disposal as a MDAS waste stream.
Laser Initiation: Laser initiation involves portable, vehicle-mounted lasers that may be used to heat surface MEC and induce detonation.	**Medium:** Still in development, although currently deployed overseas for testing. Tests show positive results for 81 millimeter (mm) and below, with reported success on munitions up to 155 mm. Produces low order type effect; subsequent debris still requires disposition.	**Low:** MEC targets must be exposed and on surface for attack by directed beam. System does require approach and placement of fiber-optic cable at appropriate position of suspected item. Laser systems still addressing power, configuration, transportability, and logistics issues. Potential impacts to natural resources because roadways and staging areas would need to be established for equipment.	**Low - Medium:** Greatly reduced manpower; added equipment, transportability and logistics concerns; no explosives required by system.	ZEUS-HLONS GATOR Laser	Disposition of resultant waste streams must be addressed in BIP operations planning and Laser initiation processes are still in the developmental stage and not used commercially.	**Low/Not Retained:** This technology is still in the developmental and is not commercially used.
Contained detonation chambers (CDCs): CDCs involve destruction of certain types of munitions in a chamber, vessel, or facility designed and constructed specifically for the purpose of containing blast and fragments. CDCs are used to destroy MEC while containing both the blast effects and the secondary waste stream within the closed system and can only be employed for munitions for which the risk of movement has been determined acceptable.	**Medium:** CDCs successfully contain hazardous components. Commonly used for fuzes and smaller explosive components. May not be used for larger munitions items found at the MRSs. Limited in use to munitions that are “acceptable to move.”	**Low:** Designed to be deployed at the project site. Logistically difficult to mobilize to the site. Could require boat transport since weight of CDC may not allow for transporting over the beach. Potential impacts to natural resources because roadways and staging areas would need to be established for equipment. Service life and maintenance are issues. Requires substantial additional handling and transport of MEC and requires items to be safe to move. Flashing furnaces have low feed rates because of safety concerns. Produces additional hazardous waste streams.	**Medium-High:** Possible construction required (e.g., berms and pads). Low feed rates equal more hours on site. Significant requirements for maintenance of system.	Kobe Blast Chamber	CDC use is limited to items that are within the net explosive weight that the system is approved to destroy and that contain fill that the unit is approved to destroy. This includes conventional munitions that contain energetics, WP, riot agents, propellants, and smoke. Air handling and filtration may be required depending on the munitions being detonated.	**Low/Not Retained:** Assumed to be very difficult to mobilize to the site and amount and type of MEC anticipated to be identified during removal can be disposed of more easily through other methods (BIP or consolidated shot).

4.4 Viable Technologies for the Tisbury Great Pond MRS

The technologies listed in Tables 4-1 to 4-5 that are the most viable options for the Tisbury Great Pond MRS are summarized in Table 4-6 and are included in the process options assembled for remedial alternatives in Section 5. Technologies summarized in Table 4-6 are the most viable options, and the majority have been demonstrated to be effective at the MRS during the RI or at a similar site.

Table 4-6. Viable Technologies

Technology		Retained for Tisbury Great Pond MRS?
Land Use Controls	Legal Mechanisms	×
	Engineering Controls	×
	Administrative Mechanisms	✓
	Physical Mechanisms	✓[a]
Detection	Visual Searching	×
	Flux-Gate Magnetometers	×
	Proton Precession Magnetometers	×
	Optically Pumped Magnetometers	×
	TDEMI Metal Detectors	✓
	Advanced EMI Sensors and Advanced Classification	×
	FDEMI Metal Detectors	✓
	Sub Audio Magnetics	×
	Magnetometer-Electromagnetic Detection Dual Sensor Systems	✓
	Airborne Synthetic Aperture Radar	×
	Airborne Laser and Infrared Sensors	×
	Synthetic Aperture Sonar	×
	BOSS	×
Positioning	Differential Global Positioning System	✓
	Robotic Total Station	✓
	Fiducial Method	×
	Odometer Method	×
	Acoustic Method	×
	Jack Stays	✓
Removal	Hand Excavation	✓
	Mechanical Excavation of Individual Anomalies	✓
	Mass Excavation and Sifting	✓
	Magnetically Assisted Removal	×
	Remotely Operated Removal	×
Disposal	Blow-in-Place	✓
	Consolidated Shots	✓
	Laser Initiation	×
	Contained Detonation Chambers	×

Notes: × Not Retained ✓ Retained

[a] Physical mechanisms such as fencing were not retained due to impracticability, but physical mechanisms such as signage were retained.

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5.0 Development and Screening of Alternatives

In this section, the technologies deemed viable for use at the Tisbury Great Pond MRS (see Section 4) 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 Section 4. 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 6 of this FS Report.

5.1 Development of Potential Remedial Alternatives

The following potential remedial alternatives have been assembled from viable technologies and general response actions for the Tisbury Great Pond MRS:

- Alternative 1 – No Action
- Alternative 2 – LUCs
- Alternative 3 – Partial subsurface clearance with LUCs
- Alternative 4 – Subsurface clearance

In accordance with DoD Manual 4715.20 (2012), a minimum of three alternatives for each MRS are required. One alternative must consider no action alternative, a second must consider an action to remediate the site to a condition that allows (UU/UE), and a third alternative will consider an action to remediate the site to a protective condition that requires LUCs. For the Tisbury Great Pond MRS, Alternative 1 meets the requirement for a no action alternative. Alternatives 2 and 3 meet the requirement for an alternative with LUCs, and Alternative 4 meets the requirement for an alternative that will achieve UU/UE.

5.2 Alternative 1 – No Action

5.2.1 Description

A “no action” alternative is required by the NCP to be developed during a FS to provide a baseline for comparison against other contemplated alternatives. In Alternative 1, the government would take no action with regard to locating, removing, and disposing of any potential MEC present within the MRS. In addition, no public awareness or education training would be initiated with regard to the risk of encountering MEC. For this alternative, it is assumed that no change to the current land use of the MRS would occur. There are no costs expected for this alternative as there is no government action and no long-term management (LTM).

5.2.2 Evaluation

Effectiveness: This alternative would not be effective at achieving the RAO of protecting recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure within and below the dunes and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion. There would be no impacts to dune vegetation under Alternative 1.

Implementability: This alternative is considered easy to implement. No construction, maintenance or monitoring would be required with this alternative.

Relative Cost: No costs are associated with this alternative since no action is required.

Summary: The No Action alternative will be retained for detailed analysis as required by the NCP.

5.3 Alternative 2 – Land Use Controls

5.3.1 Description

Risks related to encountering MEC may be managed for the MRS through a limited action alternative consisting of various LUCs. The implementation of a LUC alternative based on public awareness and education components in the Tisbury Great Pond MRS would provide a means for USACE to coordinate an effort to reduce MEC encounters by workers and recreational users and visitors (i.e., unqualified and untrained personnel) through behavior modification. Successful implementation of LUC would be contingent upon the cooperation and active participation of the workers and recreational users and visitors and authorities of the Army and other government agencies to protect the public from explosives hazards. Alternative 2 for the Tisbury Great Pond 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.

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

1. Development and distribution of informational materials to provide awareness to property owners and other land users of the presence of MEC, and the MEC that is encountered while performing recreational or maintenance, improvement, or construction activities at the MRS.

2. For the general public accessing the MRS for recreational or visiting purposes, installation and 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., recognize, retreat, and report [3Rs]).
3. Training materials and information necessary to conduct annual training would be provided to the local government and/or TTOR to offer awareness on the MEC characterized at the MRS and the 3Rs policy that will be used for future discoveries at the MRS. Attendance would be open to the public, but specifically focused on the recreational users, workers, local responders, and Town officials.

The LUCs would remain in-place to address residual hazards or risks must be managed in the long-term. LUC enforcement, review of site conditions, and maintenance activities for this alternative is a means of performing long-term management following achievement of response complete and can be performed on a periodic or as-needed basis. LUC enforcement activities would include providing recurring awareness training materials and reproduction of informational materials.

This remedial alternative will not allow for UU/UE. The NCP, at 40 CFR 300.430(f)(4)(ii), requires Five Year Reviews if the remedial action results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for UU/UE. Because this remedial alternative will result in contaminants remaining on-site above levels that allow for UU/UE, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is, or will be, protective of human health and the environment. Five Year Reviews will continue to be conducted no less often than every five years until any contaminants remaining on-site are at levels at or below those allowing for UU/UE.

5.3.2 Evaluation

Effectiveness: The effectiveness of this alternative is considered moderate. The RAO (to protect recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure in the dunes and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion) would be achieved through exposure controls. Potential impacts to human health and the environment would be minimal during the implementation of the LUCs. However, the reliability of LUCs to prevent exposure places the burden on site users to follow the 3Rs rather than removing the risk permanently.

Implementability: Implementation of this alternative is considered easy. It is technically easy to install signs, provide information to the public, and develop and provide training materials to the landowners, local government and TTOR. This alternative will require maintenance of signs and

Five Year Reviews. Administratively, this alternative is easy to implement as it does not require specialized equipment or training.

Relative Cost: Costs for this alternative are expected to be low (<$1,000,000.)

Summary: While the effectiveness of Alternative 2 (LUCs) is limited, it is retained for detailed analysis because it will achieve the RAO and can be easily implemented.

5.4 Alternative 3 – Partial Subsurface Clearance with LUCs

5.4.1 Description

Alternative 3 includes removal of subsurface MEC hazards within and below the dunes and to 3 feet below ground surface on the land within the MRS (56.5 acres), as shown on Figure 5-1. LUCs would be implemented on the remaining inland water and ocean areas. The following general tasks would be included in Alternative 3.

- Mobilization
- Site Management
- Environmental Coordination and Environmental Monitoring
- Survey and positioning
- Brush and vegetation clearing (where needed)
- Dune excavation and sifting
- Digital geophysical mapping and data analysis
- Anomaly reacquisition and resolution
- MEC removal
- Munitions potentially presenting an explosive hazard (MPPEH) disposal (e.g., BIP)
- Munitions documented as safe (MDAS) waste stream treatment (off-site) disposal
- Site restoration
- Post construction vegetation monitoring
- Demobilization
- Development and reproduction of training materials
- Annual sign maintenance
- Long Term Monitoring
- Five Year Reviews

This alternative would involve the excavation and sifting of the dunes, which comprise approximately 5 acres of the MRS. It is estimated that the dunes are 12 feet high. The dunes would be excavated in lifts and the sand would be sifted to remove MEC. Approximately 3 ft and possibly up to 6 ft below the dunes would also be excavated and sifted. DGM would be conducted at the base of the excavation and individual anomalies excavated as needed to a total depth of 3 ft to possibly 6 ft below the base of the dune. However, if anomalies are detected below a dug anomaly, they will be investigated, removed, and properly disposed of. The dunes would be restored upon completion of sifting operations.

The remainder of the area would utilize DGM and data analysis, followed by anomaly reacquisition and resolution and MEC removal and disposal. Prior to DGM activities, a small portion of the area would require vegetation removal to gain access during the clearance. Intrusive activities are anticipated to occur within the top three feet of soil. However, if anomalies are detected below three feet, they will be investigated, removed, and properly disposed of. Disposal of removed vegetation will be coordinated with TTOR, landowners, and USACE subject matter experts during the development of the remedial action work plan to ensure the habitat is not detrimentally affected. Detection of MEC 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. 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.

Anomalies would be reacquired using a robotic total station. Intrusive activities would be performed using hand-tools and restoration of disturbed areas would be required. Any MPPEH recovered during the 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.

Because sensitive species are known to exist within the MRS, this alternative will require coordination with MA NHESP, TTOR, and USFWS. Coordination with USFWS will establish conditions for working in areas where federally listed species may be present. A rare plant and wildlife habitat evaluation will be conducted during development of the work plan in accordance with MA NHESP guidelines. Fieldwork would be scheduled to avoid sensitive species as much as possible. In addition, biological monitoring during the remedial action and possibly habitat restoration would be required as a mitigation measure.

Unavoidable adverse impacts to vegetation would occur as a result of this alternative and would require restoration in areas where vegetation was cleared. Detailed restoration measures would be presented in the remedial action work plan coordinated with TTOR and resource agencies.

LUCs would be implemented as described in Alternative 2. This alternative would require Five Year Reviews; however, these reviews are not considered as part of the remedy for Alternative 3.

US Army Corps of Engineers

NOTES:
2009 Aerial Data Source: MassGIS

0 400 800 1,200 1,600 2,000 Feet

0 75 150 225 300 375 Meters

FIGURE 5-1

Alternative 3: Partial Subsurface Clearance with LUCS - Tisbury Great Pond Munitions Response Area, Martha's Vineyard, MA

04/22/2015	Rev:	Drawn: JBO	Chk: DMS	Tisbury_TGP_MRS_Alt_3_FS.mxd	PROJ: 562910000

5.4.2 Evaluation

Effectiveness: This alternative is considered moderately to highly effective. The RAO (to protect recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure within and below the dunes and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion) would be achieved to a high degree of certainty and would allow recreation activities that could involve intrusive activities to occur. LUCs would be effective within the inland water and ocean areas of the MRS to prevent exposure to MEC. This alternative uses proven and reliable technologies that will permanently remove the MEC hazard from a portion of the site. While this alternative presents potential impacts to human health and the environment during implementation (UXO personnel and dune loss), the impacts will be minimized through use of safety plans and coordination with MADEP, MA NHESP and TTOR as necessary.

Implementability: The implementability of Alternative 3 is considered moderate. This alternative can be readily implemented and resources and equipment are available. This alternative will require maintenance of signs and Five Year Reviews, and specialized equipment and personnel with specialized training will be required to successfully implement a subsurface clearance.

Relative Cost: The cost of conducting this alternative (Partial Subsurface Clearance with LUCs) is considered high (>$5M).

Summary: Since this alternative would be highly effective in achieving the RAO and reducing the hazards associated with MEC, this alternative will be retained for detailed analysis.

5.5 Alternative 4 –Subsurface Clearance

5.5.1 Description

Alternative 4 includes clearing the entire 123.1 acre MRS of subsurface MEC to 3 feet below ground surface, and up to possibly 6 ft under the dunes as illustrated in Figure 5-2. The following general tasks would be included in Alternative 4.

- Mobilization
- Site management
- Environmental Coordination and Environmental Monitoring
- Survey and positioning
- Brush clearing (where needed)
- Dune excavation and sifting
- "Mag & dig" within the ocean area

- Digital geophysical mapping and data analysis within the inland water and land areas
- Anomaly reacquisition and resolution
- MEC removal
- MPPEH disposal (e.g., BIP)
- MDAS waste stream treatment (off-site) disposal
- Site restoration
- Post construction vegetation monitoring
- Demobilization
- Development and reproduction of training materials
- Annual sign maintenance

After all clearance operations are complete, a review of the site will be made (similar to a CERCLA 5 year review) that will ensure the effectiveness of the remedial actions for UU/UE and ensure that vegetation restoration activities are successful.

Alternative 4 requires clearance activities in all four areas of the MRS: dunes, land, inland water, and ocean (Figure 5-2).

Dunes: Similar to Alternative 3, Alternative 4 will require the excavation and sifting of the dunes, which comprise approximately 5 acres of the MRS. The dunes would be excavated in lifts and the sand would be sifted to remove MEC. Approximately 3 feet below the dunes would also be excavated and sifted. DGM would be conducted at the base of the excavation and individual anomalies excavated as needed to a total depth of 3 ft up to possibly 6 ft below the base of the dune. However, if anomalies are detected below a dug anomaly, they will be investigated, removed, and properly disposed of. The dunes would be restored upon completion of sifting operations.

Land: Some vegetation clearance could be necessary to gain access during the clearance. Disposal of removed vegetation will be coordinated with TTOR, landowners, and USACE subject matter experts during the development of the remedial action work plan to ensure the habitat is not detrimentally affected. Detection of MEC on land 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. 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.

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.

* Total Inland Water acreage includes the portion of inland water within Tisbury Great Pond and the portion within Long Cove.

US Army Corps of Engineers

NOTES:
2009 Aerial Data Source:
MassGIS

UXB
amec

0 400 800 1,200 1,600 2,000 Feet

0 75 150 225 300 375 Meters

FIGURE 5-2

Alternative 4: Subsurface Clearance - Tisbury Great Pond Munitions Response Area, Martha's Vineyard, MA

04/22/2015	Rev:	Drawn: JBO	Chk: DMS	Tisbury_TGP_MRS_Alt_4_FS.mxd	PROJ: 562910000

Because sensitive species are known to exist within the MRS, this alternative will require coordination with MA NHESP, TTOR, and USFWS. Coordination with USFWS will establish conditions for working in areas where federally listed species may be present. A rare plant and wildlife habitat evaluation will be conducted during development of the work plan in accordance with MA NHESP guidelines. Fieldwork would be scheduled to avoid sensitive species as much as possible. In addition, biological monitoring during the remedial action and possibly habitat restoration, would be required as mitigation measures.

Unavoidable adverse impacts to vegetation would occur as a result of this alternative and would require site restoration in areas where vegetation was cleared. . Detailed restoration activities and post construction vegetation monitoring would be presented in the remedial action work plan and coordinated with TTOR and resource agencies.

Inland Water: DGM would be utilized on the entire the MRS using a boat-towed EM61-MK2 or similar. Positioning for the digital instrumentation would be conducted using a GPS. 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.

Anomalies identified during DGM activities would be reacquired using a robotic total station and anomaly resolution (or intrusive activities) would be performed using a combination of hand-tools, as successfully accomplished during the RI, and mechanical methods. Mechanical methods (such as a marsh buggy or similar excavator with floatation tracks) would be used for deeper anomalies which could require excessive time to dig by hand underwater.

Work plans will require coordination with the MA Division of Marine Fisheries, NOAA, and town Shellfish Advisory Committees.

Ocean: Due to the dynamic nature of the ocean surf zone, a “Mag and Dig” technique will be used for ocean clearance activities. Divers identified anomalies on transects using an underwater hand-held analog instrument, and subsequently excavated each anomaly as it was found.

Common activities for all MRS areas:

Any MPPEH recovered during the 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.

Based on the RI findings, there is a low probability for encountering MEC other than MK-23 practice bombs with spotting charges. However, for protection of the public during remedial activities, informational materials will be developed and distributed to property owners, awareness training materials will be developed and distributed, and signs will be installed to ensure the safety of land owners, workers, and the public. After work is complete a close-out report will be issued and provided to the State of Massachusetts.

5.5.2 Evaluation

Effectiveness: This alternative would be highly effective. The RAO (to protect recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure in and below the dunes and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion) would be achieved to a high degree of certainty. This alternative uses proven and reliable technologies that will permanently remove the MEC hazard from the site. While this alternative presents potential impacts to human health and the environment during implementation (UXO personnel and dune loss), the impacts will be minimized through use of safety plans and coordination with MADEP, MA NHESP and TTOR as necessary.

Implementability: The implementability of Alternative 4 is considered moderate. This alternative can be readily implemented and resources and equipment are available. Specialized equipment and personnel with specialized training will be required to successfully implement a subsurface clearance and some vegetation clearance will be required. In addition, subsurface clearance activities within water present some technical difficulties due to the dynamic nature of the water and reduced visibility underwater

Relative Cost: The cost of conducting a subsurface clearance across the entire MRS is considered high (>$5M).

Summary: Since this alternative would be highly effective in achieving the RAO and reducing the hazards associated with MEC, this alternative will be retained for detailed analysis.

5.6 Screening of Potential Remedial Alternatives

The results of the initial screening of potential remedial alternatives assembled for the Tisbury Great Pond MRS is presented in Table 5-1 using the three criteria of effectiveness, implementability, and cost. As a result of the screening, all of the alternatives were considered viable and were retained for further evaluation.

Table 5-1. Screening of Potential Remedial Alternatives for the Tisbury Great Pond MRS

Alternative	Relative Effectiveness	Implementability	Relative Cost	Overall Viability[a]
Alternative 1: No DoD Action Indicated	Low	Easy	None	Required by NCP to be retained
Alternative 2: Land Use Controls	Moderate	Easy	Low	Moderate: Retained
Alternative 3: Partial Subsurface Clearance with Land Use Controls	Moderate-High	Moderate	High	Moderate: Retained
Alternative 4: Subsurface Clearance	High	Moderate	High	High: Retained

Note: [a] Overall viability primarily considers the relative effectiveness and implementability.

6.0 Detailed Analysis

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 Tisbury Great Pond MRS is assessed against the NCP evaluation criteria described in Subsection 6.1. 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 MRS, and to demonstrate satisfaction of the CERCLA remedy selection requirements in the DD.

Based on the screening of potential alternatives for the Tisbury Great Pond MRS (Table 5-1), the following alternatives will be evaluated in detail against the NCP criteria:

- Alternative 1 – No Action
- Alternative 2 – LUCs
- Alternative 3 – Partial Subsurface Clearance with LUCs
- Alternative 4 – Subsurface Clearance

6.1 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.

As described in the NCP, the following two "threshold criteria" must be met in order for the alternative to be considered further:

1. **Overall protectiveness of human health and the environment -** Determines whether an alternative achieves the RAO 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 Tisbury Great Pond MRS alternatives are summarized in Table 6-1.

Table 6-1. ARARs Identified for Tisbury Great Pond MRS Alternatives

ARAR	Alternative 1 – No Action	Alternative 2 – LUCs	Alternative 3 – Partial Subsurface Clearance with LUCs	Alternative 4 – Subsurface Clearance
16 U.S.C. §1538(a)(1)	x	x	✓	✓
40 CFR 264.601	x	x	✓	✓
321 CMR 10.04(1)	x	x	✓	✓
321 CMR 10.23(1)	x	x	✓	✓
321 CMR 10.23(2)	x	x	✓	✓
321 CMR 10.23(3)	x	x	✓	✓
321 CMR 10.23 (6) (b) (1)	x	x	✓	✓
321 CMR 10.23(6) (b) (2)	x	x	✓	✓
321 CMR 10.23(7) (a)	x	x	✓	✓
321 CMR 10.23(7) (b)	x	x	✓	✓
310 CMR 9.40 (2)(b) (1st sentence)	x	x	✓	✓
310 CMR 9.40 (3)(b) (1st sentence)	x	x	✓	✓
310 CMR 10.25 (5) Land under the Ocean	x	x	x	✓
310 CMR 10.25 (6) Land under the Ocean	x	x	x	✓
310 CMR 10.25 (7) Land under the Ocean	x	x	x	✓
310 CMR 10.27 (3) Coastal Beaches	x	x	✓	✓
310 CMR 10.27 (6) Coastal Beaches	x	x	✓	✓
310 CMR 10.27 (7) Coastal Beaches	x	x	✓	✓
310 CMR 10.28 (3) Coastal Dunes	x	x	✓	✓
310 CMR 10.28 (6) Coastal Dunes	x	x	✓	✓
310 CMR 10.33 (3) Land under Salt Ponds	x	x	✓	✓
310 CMR 10.33 (5) Land under Salt Ponds	x	x	✓	✓
310 CMR 10.34 (4) Land Containing Shellfish	x	x	✓	✓
310 CMR 10.34(5) Land Containing Shellfish	x	x	✓	✓

ARAR	Alternative 1 – No Action	Alternative 2 – LUCs	Alternative 3 – Partial Subsurface Clearance with LUCs	Alternative 4 – Subsurface Clearance
310 CMR 10.34 (8) Land Containing Shellfish	x	x	✓	✓
310 CMR 10.35(3) Banks of or Land under the Ocean, Ponds, Streams, Rivers, Lakes or Creeks that Underlie an Anadromous/Catadromous Fish Run	x	x	✓	✓
310 CMR 10.35(4) Banks of or Land under the Ocean, Ponds, Streams, Rivers, Lakes or Creeks that Underlie an Anadromous/Catadromous Fish Run	x	x	✓	✓
310 CMR 10.35(5) Banks of or Land under the Ocean, Ponds, Streams, Rivers, Lakes or Creeks that Underlie an Anadromous/Catadromous Fish Run	x	x	✓	✓
310 CMR 10.37 5th paragraph, 1st sentence, Estimated Habitats of Rare Wildlife (for Coastal Wetlands)	x	x	✓	✓
310 CMR 10.55 (4)(a) Bordering Vegetated Wetlands (Wet Meadows, Marshes, Swamps and Bogs)	x	x	✓	✓
310 CMR 10.55 (4)(b) Bordering Vegetated Wetlands (Wet Meadows, Marshes, Swamps and Bogs)	x	x	✓	✓
310 CMR 10.55 (4)(d) Bordering Vegetated Wetlands (Wet Meadows, Marshes, Swamps and Bogs)	x	x	✓	✓
314 CMR 9.06 (2)(1st sentence)	x	x	✓	✓
314 CMR 9.07 (1)(a)(1st sentence)	x	x	✓	✓

Notes: × Not Identified as ARAR for Alternative ✓ Identified as ARAR for Alternative

See Section 3.0 for further explanation of the specific provisions which are potential ARARs.

No ARARs were identified associated with Alternatives 1 or 2. Table 6-1 identifies the ARARS for Alternatives 3 and 4 involving clearance activities.

The following five "balancing criteria" described below are weighed against each other and are the primary criteria upon which the detailed analysis is based:

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, the adequacy of the alternative in limiting the risk, the need for long-term monitoring and management, and the administrative feasibility of maintaining the LUCs and the potential risk should they fail. The evaluation also considers mechanisms such as the CERCLA Five Year Review process to assess on a periodic basis the long-term effectiveness and permanence, as well as the protectiveness, of the alternative.

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

5. **Short-term effectiveness -** Considers the length of time needed to implement an alternative and the risks the alternative poses to workers, residents, and the environment during implementation. In addition, for MEC, safety considerations include an evaluation of what resources available and how long it will take to mitigate MEC risks and achieve the RAO.

6. **Implementability -** Considers the technical and administrative feasibility of implementing the alternative, including factors such as the relative availability of goods and services, and the relative effort associated with implementation of the alternative.

7. **Cost -** Includes estimated capital costs. Costs provided in the Detailed Analysis section include Remedial Alternative Costs plus Five Year Review costs and safety review costs ($42,000 per review) to provide a meaningful comparison. However, review costs are calculated separately from the remedial alternative. Cost estimates are expected to be accurate within a range of +50% to -30% (EPA, 1988).

The last two criteria, the “modifying criteria,” are usually evaluated following the receipt of comments on the Proposed Plan, 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 (Massachusetts Department of Environmental Protection) 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.

6.2 Alternative 1 – No Action

The No Action alternative for the Tisbury Great Pond MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment –** Alternative 1 would not be protective of human health and the environment.

   The MEC HA conducted during the RI estimated the land portions of the MRS to have a Hazard Level 1, indicating the highest potential explosive hazard condition. The MEC HA was revised during the FS to consider a no action alternative. The MEC HA indicates that implementation of a no action alternative would not change the MEC HA score and the site would continue to have a high potential explosive hazard condition. The revised MEC HA worksheets are provided in Appendix C.

2. **Compliance with ARARs -** There are no ARARs associated with Alternative 1.

3. **Long-Term Effectiveness and Permanence –** Alternative 1 is not expected to reduce the magnitude of risk over the long term based on intended future land use. The no action alternative requires no technical components and poses no uncertainties regarding its performance. Exposure to MEC is anticipated to increase over time with continued land use throughout the MRS by the public; therefore it would not provide long-term effectiveness and permanence.

4. **Reduction of TMV of Contaminants Through Treatment -** Alternative 1 would not reduce the toxicity, volume or mobility associated with the MEC explosive hazards within the MRS.

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

6. **Implementability –** Alternative 1 is considered easily implementable. It poses no technical difficulties and no permits or coordination with other agencies would be required.

7. **Cost -** The total cost to perform Alternative 1 is $0.

6.3 Alternative 2 – Land Use Controls

Alternative 2 – LUCs for the Tisbury Great Pond MRS is evaluated relative to the NCP criteria as follows:

1. **Overall Protectiveness of Human Health and the Environment -** Alternative 2 would be protective since it controls exposure through LUCs.

   MEC was identified during the RI in the subsurface of the MRS and the MEC HA conducted during the RI estimated the land portions of MRS as a Hazard Level 1, indicating the highest potential explosive hazard condition. The MEC HA was revised during the FS to consider Alternative 2 (Appendix C). The MEC HA indicates that implementation of LUCs would not change the MEC HA score and the site would continue to have a high potential explosive hazard condition. However, LUCs such as signage and educational programs would inform the public of the threat and provide information to assist with recognition of MEC, thereby controlling exposure to MEC.

2. **Compliance with ARARs -** There are no ARARs associated with Alternative 2.

3. **Long-Term Effectiveness and Permanence –** Alternative 2 would provide protectiveness through LUCs as long as the LUCs remain in place. Since this alternative reduces the exposure to MEC rather than the amount of MEC, it is contingent upon the cooperation and active participation of the local government with existing property owners (TTOR and private owners), local responders, and the public using the MRS. The LUC components for risk management include printed informational materials such as signs, brochures, fact sheets, and providing training materials awareness and 3Rs protocol to be followed if MEC is encountered in the future.

   Maintaining the LUCs in the long term is required. If the LUC components fail, there would be a risk of untrained personnel handling MEC when encountered. LUC enforcement (i.e., awareness training and review and reproduction of informational materials), periodic inspections (at least annually) and maintenance (i.e., installed signs) would be conducted to ensure that LUCs remain effective and that the land use has not changed. Reviews would also be conducted once every 5 years as required by CERCLA to determine if the remedy is or will be protective of human health and the environment.

4. **Reduction of TMV of Contaminants Through Treatment** - Alternative 2 will not reduce the toxicity, mobility or volume of contaminants and does not satisfy the statutory preference for treatment as a principal element of the remedy.

5. **Short-Term Effectiveness -** There would be no additional risk to workers, residents or the environment because there are no construction intrusive activities associated with

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

6. **Implementability -** The LUC components recommended in Alternative 2 can be readily implemented. 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 readily developed and disseminated.

7. **Cost -** The total cost to perform Alternative 2 is $622,000. This cost has been rounded to the nearest thousand dollars. The cost estimate for Alternative 2 is provided in Appendix D.

   This alternative would require Five Year Reviews to be conducted. These costs are included in the alternative cost above estimated to be $42,000 for each review required.

6.4 Alternative 3 – Partial Subsurface Clearance with LUCs

Alternative 3 – Partial Subsurface Clearance of MEC is evaluated relative to the NCP criteria for the Tisbury Great Pond MRS as follows:

1. **Overall Protectiveness of Human Health and the Environment -** Alternative 3 would provide protection since it would reduce the threat of exposure to MEC by eliminating MEC in the dunes and land portions of the MRS and by controlling exposure through LUCs on the remaining inland water and ocean areas.

   Based on the results of the RI, 100% of MEC present in the MRS was discovered within the subsurface (UXB, 2014). The MEC HA conducted during the RI estimated the Tisbury Great Pond MRS was a Hazard Level 1, indicating the highest potential explosive hazard condition. The MEC HA was revised during the FS to consider Alternative 3. The MEC HA indicates that after a partial clearance of the MRS, the explosive hazard would be reduced to a Hazard Level 4, which is the lowest potential explosive hazard condition. Please note that the MEC HA does not take into account underwater MEC hazards.

   The implementation of this alternative creates safety risks for the remedial workers. An Explosives Safety Plan would be developed and followed to minimize threats to workers. The MEC 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 are not acceptable to move would be BIP. The BIP demolition results in a more confined waste stream than consolidation and is, therefore, more 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 mitigation techniques.

2. **Compliance with ARARs –** Thirty-one ARARs were identified for the Tisbury Great Pond MRS Alternative 3 (See Table 6-1). Alternative 3 would comply with all ARARs and procedures for ensuring compliance would be developed in the Remedial Action Work Plan. Clearance of MEC (including using a consolidated shot approach is needed) would be performed to fulfill all DoD and EPA guidance for munitions response and explosives safety. Work would also be conducted to comply with 16 U.S.C. §1538(a)(1) and 321 CMR 10.04 (1) by avoiding impacts to threatened and endangered species.

3. **Long-Term Effectiveness and Permanence -** Clearance of MEC in the subsurface would provide long-term effectiveness by permanently removing MEC from the most accessible portions of the MRS and preventing MEC exposure through LUCs in the remainder of the MRS. This alternative is contingent upon the cooperation and active participation of the local government with existing property owners, local responders, and the public using the MRS.

   Maintaining the LUCs in the long term is required. If the LUC components fail, there would be a risk of untrained personnel handling MEC when encountered. LUC enforcement (i.e., awareness training and review and reproduction of informational materials), periodic inspections (at least annually) and maintenance (i.e., installed signs) would be conducted to ensure that LUCs remain effective and that the land use has not changed. Reviews would also be conducted once every 5 years as required by CERCLA to determine if the remedy is or will be protective of human health and the environment.

4. **Reduction of TMV of Contaminants Through Treatment -** Clearance would fully eliminate the TMV of MEC in a portion of the MRS. Alternative 3 satisfies the statutory preference for treatment as a principal element of the remedy because MEC would be destroyed. Alternative 3 would not fully eliminate MEC since only a portion of the MRS would undergo clearance.

5. **Short-Term Effectiveness –** In the short-term, signage informing the public of the hazard would provide a decrease in exposure to the hazard. There would be an increase in risk to workers and the environment since the work involves exposure to potentially explosive items. These risks would be mitigated through use of SOPs for conducting

MEC removals. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Equipment or material staging areas may be required, but could be constructed within a designated area within the MRS. Some vegetation clearance is anticipated, therefore there would be some impacts to the environment and potential impacts to rare species. Procedures for minimizing, reducing or mitigating negative effects would be developed in the Remedial Action Work Plan. It is estimated that partial clearance under Alternative 3 would require approximately 5 months of fieldwork to implement. Approximately 6 months would be required to establish LUCs associated with Alternative 3.

6. **Implementability -** Subsurface clearance of MEC is technically and administratively feasible and can be implemented at the MRS, as demonstrated during the RI. Materials and services to perform Alternative 3 are readily available. Coordination with MADEP, MA NHESP and TTOR is required for this alternative.

7. **Cost—**The total cost to perform Alternative 3 at the Tisbury Great Pond MRS is $8,079,000. The cost estimate for Alternative 3 is provided in Appendix D.

This alternative would require Five Year Reviews to be conducted. These costs are included in the alternative cost above estimated to be $42,000 for each review required.

6.5 Alternative 4 – Subsurface Clearance

Alternative 4 – Subsurface Clearance of MEC is evaluated relative to the NCP criteria for the Tisbury Great Pond MRS as follows:

Overall Protectiveness of Human Health and the Environment - Alternative 4 would provide protection since it would eliminate MEC exposure within the MRS. Based on the results of the RI, 100% of MEC present in the MRS was discovered within the subsurface (UXB, 2014). The MEC HA conducted during the RI estimated the MRS was a Hazard Level 1, indicating the highest potential explosive hazard condition. The MEC HA was revised during the FS to consider Alternative 4. The MEC HA indicates that after a partial clearance of the Tisbury Great Pond MRS, the explosive hazard would be reduced to a Hazard Level 4, which is the lowest potential explosive hazard condition.

Like Alternative 3, the implementation of Alternative 4 creates safety risks for the remedial workers. An Explosives Safety Plan would be developed and followed to minimize threats to workers. The MEC 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 are not acceptable to move would be BIP. The BIP demolition results in a more confined waste stream than consolidation and is, therefore, more 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 mitigation techniques.

2. **Compliance with ARARs –** Thirty-four ARARs were identified for the Tisbury Great Pond MRS Alternative 4 (See Table 6-1). Alternative 4 would comply with all ARARs and procedures for ensuring compliance would be developed in the Remedial Action Work Plan. Clearance of MEC (including using a consolidated shot approach is needed) would be performed to fulfill all DoD and EPA guidance for munitions response and explosives safety. Work would also be conducted to comply with 16 U.S.C. §1538(a)(1) and 321 CMR 10.04 (1) and (2) by avoiding impacts to threatened and endangered species.

3. **Long-Term Effectiveness and Permanence** - Clearance of MEC within the MRS would provide long-term effectiveness by permanently eliminating MEC from the MRS. During the remedial process, educational materials would be distributed and signs would be erected.

4. **Reduction of TMV of Contaminants Through Treatment -** This alternative would fully eliminate the TMV of MEC through subsurface clearance. Alternative 4 satisfies the statutory preference for treatment as a principal element of the remedy because MEC would be destroyed.

5. **Short-Term Effectiveness –** In the short-term, signage informing the public of the hazard would provide a decrease in exposure to the hazard. There would be an increase in risk to workers and the environment since the work involves exposure to potentially explosive items. Impacts to local residents and the public may occur, but would be temporary and limited to the immediate work area. Equipment or material staging areas may be required, but could be constructed within a designated area within the MRS. Dune removal and restoration will be required for this alternative. Procedures for minimizing, reducing or mitigating negative effects to the environment, including rare species and rare species habitat, would be developed in the Remedial Action Work Plan. It is estimated that Alternative 4 would require approximately 6 months of field work to implement.

6. **Implementability -** Subsurface clearance of MEC is technically and administratively feasible and can be implemented at the Tisbury Great Pond MRS, as demonstrated during

the RI. Materials and services to perform Alternative 4 are readily available. Coordination with MADEP, MA NHESP and TTOR is required for this alternative.

7. **Cost—**The total cost to perform Alternative 4 at the MRS is $9,868,000. The cost estimate for Alternative 4 is provided in Appendix D.

   This alternative will also have a review cost. These costs are included in the alternative cost above estimated to be $42,000 for each review required.

6.6 Comparative Analysis of Remedial Alternatives

Based on the detailed analysis of remedial alternatives, the strengths and weaknesses of the remedial alternatives relative to one another are evaluated with respect to each of the NCP criteria below.

1. **Overall Protectiveness of Human Health and the Environment -** Because MEC was identified during the RI in the subsurface, and the MEC HA estimated an explosive risk is anticipated to be present at the Tisbury Great Pond MRS, the threat of human exposure to MEC and the potential for MEC to be handled by unqualified and untrained personnel exists. Alternative 1 would not eliminate, reduce, or control the threat of human exposure to subsurface MEC; therefore it does not meet the threshold criteria and cannot be considered further. Alternative 2 would be protective since it controls exposure through LUCs. Alternative 3 provides protectiveness as MEC would be destroyed throughout the dunes and land portion of the MRS and would control exposure through LUCs in the underwater portion of the MRS. Alternative 4 is protective of human health because subsurface MEC would be destroyed from the entirety of the MRS. Risks to the environment associated with Alternative 4 are greatest and would require extensive planning, management, monitoring of endangered and threatened species, and restoration.
2. **Compliance with ARARs -** There are no ARARs associated with Alternative 1 or Alternative 2, and Alternatives 3 and 4 would be implemented and performed to comply with all ARARs. Fieldwork for Alternatives 3 and 4 would be conducted to minimize adverse affects to endangered or threatened species and habitats. Alternatives 3 and 4 would require a biologist to survey the area prior to any intrusive work to ensure clearance activities. Alternative 4 would be the most intrusive in nature and would require significant attention to avoid impacts on listed species.
3. **Long-Term Effectiveness and Permanence – Alternative 1 would not provide long-term effectiveness.** Alternative 2 would be protective since it controls exposure through LUCs. However, it relies on exposure control rather than removal or treatment. Under Alternative 3, all MEC would be destroyed within the land and beach portions of the MRS, but would still require LUCs in the long-term. Alternative 4 would remove MEC

hazards from within the entirety of the MRSs and would be the most effective and permanent remedial alternative over the long-term because it would eliminate risk regardless of the future use of the property.

4. **Reduction of TMV of Contaminants Through Treatment -** Alternatives 1 and 2 would not reduce the TMV of MEC within the MRS. Alternative 3 would be effective in the reduction of TMV through removal of all MEC within the land and beach portions of the MRS. Alternative 4 would be the most effective in reducing the TMV of MEC because all detectable MEC throughout the entirety of the MRS would be destroyed. Alternatives 3 and 4 would satisfy the statutory preference for treatment as a principal element of the remedy because MEC would be destroyed.

5. **Short-Term Effectiveness -** Alternative 1 would provide no short term effectiveness. Alternative 2 would not present significant additional risk to the public or workers at the MRS. Alternatives 3 and 4 would increase risk to the public and workers during clearance of MEC to variable degrees based on the implementation of exclusion zones for intrusive activities 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. Alternatives 3 and 4 would cause some damage to the environment because of the dune removal required to conduct subsurface activities on a portion of the MRS. The time durations required to complete Alternative 2 is estimated at 6 months. Alternatives 3 and 4 would require 5 and 6 months, respectively, to complete the field work.

6. **Implementability –** Alternatives 1 and 2 would both be easily implementable. Alternatives 3 and 4 would also be implementable, but would require considerable more effort and manpower than Alternatives 1 and 2. Subsurface clearance technologies are proven and were successfully implemented within the MRS during the RI. Alternative 4 would be more difficult to implement than Alternative 3 since it involves underwater clearance, which requires specialized UXO-divers. Specific activities, including development of awareness training materials for workers and use of protection procedures and mitigation techniques would be required to preserve environmental resources during Alternatives 3 and 4.

7. **Cost—**The total cost (Remedial Alternative cost plus review costs) to perform each alternative is as follows:

   - Alternative 1 = $0
   - Alternative 2 = $622,000
   - Alternative 3 = $8,079,000

- Alternative 4 = $9,868,000

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

Table 6-1 presents the comparative summary of the detailed analysis of the alternatives for the Tisbury Great Pond MRS. The Subsurface Clearance of the entirety of each MRS most favorably meets all of the evaluated detailed analysis criteria as compared to other alternatives. While the complete subsurface clearance alternatives would require the most manpower and time to implement, they would provide the highest level of protectiveness over the long-term and will achieve the RAO of protecting recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure within and below the dunes, and in the top three feet of subsurface soil or sediment during intrusive activities and by dune erosion.

Table 6-2 Comparative Summary of Detailed Analysis of Remedial Alternatives

Tisbury Great Pond MRS Alternatives					
					Preferred
Criteria		Alternative 1: No Action	Alternative 2: LUCs	Alternative 3: Partial Subsurface Clearance with LUCs	Alternative 4: Subsurface Clearance
Threshold	1. Overall Protection of Human Health and Environment	■	●	●	●
	2. Compliance with ARARs	●	●	●	●
Balancing	3. Long-Term Effectiveness	■	□	□	●
	4. Reduction of TMV through Treatment	■	■	□	●
	5. Short-Term Effectiveness	■	●	□	□
	6. Implementability	●	●	●	●
	7. Cost[1]	$0	$622,000	$8,079,000	$9,868,000
Modifying[2]	8. State Acceptance	TBD	TBD	TBD	TBD
	9. Community Acceptance	TBD	TBD	TBD	TBD

Notes: [1] Costs for the preferred alternatives are provided in Appendix D. Costs provided here include Remedial Alternative Costs plus review costs ($42,000 per review) to provide a meaningful comparison.
[2] The modifying criteria will be evaluated after the Proposed Plan following review and input from these parties.

● Favorable (Pass for threshold criteria)
□ Moderately Favorable
■ Not Favorable (Fail for threshold criteria)

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APPENDIX A: UPDATED CONCEPTUAL SITE MODEL

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Revised Conceptual Site Model Summary, Tisbury Great Pond Investigation Area

Facility Profile	Physical Profile	Release Profile	Land Use and Exposure Profile	Ecological Profile
Facility Description: • Approximately 768 acres. (1) • Located in the southwest portion of Martha’s Vineyard, Massachusetts, which is bound to the south by the Atlantic Ocean and to the north, east, and west by privately and publicly owned land. • No permanent structures were constructed by the U.S. Navy at the site. (2) **Site History:** • Between August 1943 and July 1947, the site served as a practice dive bombing and strafing range in support of the fighter training program (1). • Records do not indicate that the property was ever used to store, transport, treat, or dispose of the associated munitions used on property (2). **Munitions Potentially Used:** • 0.30 and 0.50 caliber ammunition; • Miniture practice bombs, AN-MK 5, 15, 21, 23, and 43; • 2.25 and 5” rocket motors • Spotting charges may have been used with the practice bombs (AN-MK 4, 6 or 7).	**Site Characteristics:** • Approximately 146 acres of land • Approximately 62 acres of beach • Approximately 508 acres of inland water • Approximately 52 acres of ocean (1) **Topography:** • Relatively flat with sand dunes. • Elevations within beach area ranges from approximately 0 to 22 ft above msl. • Elevations within land areas range from approximately 1 to 21 ft above msl. **Vegetation:** • Predominately low grass vegetation and areas of barren beaches. The northern portion of the site is covered with trees and shrubs (1). **Surface Water:** • Tisbury Great Pond is a salt-water pond that fills during the winter storms. Each spring a natural channel, located on the western end of the sand spit, which divides the pond from the Atlantic Ocean, is reopened. This action allows 3 to 4 feet of water to drain back to the ocean. **Soils:** • Predominately medium to fine grained sand with trace quantities of silt and have high permeability. Soils adjacent to the Tisbury Great Pond contain larger amounts of fine sediments and high organic material content and have low permeability (2). • The thickness of the soil ranges from 0 to greater than 10 ft (2). **Geology:** • Glacial deposits consisting of recent beach and marsh sediments, glacial deposits, interglacial deposits, and glacially deformed ancient coastal plain sediments (2). • Bedrock is encountered at approximately 500 ft bgs and is comprised of metamorphic and igneous rocks (2). **Hydrogeology:** • In the northern portion of the site, groundwater is encountered at approximately 5 to 15 ft bgs, while groundwater at other portions of the site is encountered at approximately 1 to 2 ft bgs (2). • The shallow freshwater aquifer is underlain by brackish groundwater that is unsuitable for human consumption (2). • Groundwater empties into Tisbury Great Pond (2). **Meteorology:** • Average Annual Rainfall = 46 inches per year. (2)	**Contaminants of Potential Concern:** • Lead in soil • Lead and nickel in sediment • Suspected HE bomb (MEC) found in August 2009. **Media of Potential Concern:** • Surface soil, subsurface soil, and sediment **Confirmed MEC:** • MEC was identified during intrusive investigations at the following locations: - One MK23 on land east of Tisbury Great Pond; - Three MK23s with intact spotting charges found in the northwest portion of Tisbury Great Pond; and, - Two MK23s in the ocean south of the “Cut.” • An unknown bomb was discovered by the public in August 2009 on the beach west of the “Cut.” There is no supporting evidence through historical research or the RI that the bomb was part of historical military operations conducted at South Beach and will be considered an isolated find. **Confirmed MD:** • During the 2010-2011 Remedial Investigation, 31 MD items were identified within inland water (13 MD items) and ocean (18 MD items) adjacent to the “Cut.” **MC Sampling:** • During the 2008 SI, environmental samples were collected and analyzed for explosives and metals. Soil: – All six metals (antimony, copper, lead, nickel, strontium, and zinc) detected above background but below residential and industrial screening levels. – Antimony and lead exceeded eco-SSLs in four of six soil samples. Sediment: – All six metals detected above background but below screening values. Surface Water: – From the SI, nickel and strontium detected in all three samples, but below human health screening values. – Strontium exceeded eco-SSLs in all three samples (2). • During the 2010-2011 RI, surface, subsurface, sediment, and groundwater samples were collected. Sample results indicate that MC concentrations do not exceed human health screening criteria. Lead was detected in soil at concentration exceeding ecological screening criterion. Lead and nickel were detected in sediment at concentrations exceeding ecological screening criterion in both investigationa and background samples. **Identified Pathways:** • Lead and nickel detected in soil and/or sediment at concentrations above ecological screening criterion. Results indicate that adsorption of MCs to soil/sediment particles have been the primary mechanism influencing the extent of MCs in the environment. No significant risk was identified in the Baseline Human Health Risk Assessment. • MD items are transported by washing up on the beach or are exposed from beach erosion. • MEC items are transported by various physical factors/transport processes that include: ocean currents; natural erosion of soil by wind and water exposing buried MEC items; and, relocation or removal by the public.	**Current Landowners:** • The Trustees of Reservations (TTOR), the Commonwealth of Massachusetts (inland and coastal waters), and private landowners (2). **Current Land Use:** • After military use of the property ended, Tisbury Great Pond was developed into a shellfish harvest area (2). • The Great Pond is a designated Commonwealth of Massachusetts shellfish fisheries area and is actively harvested for oysters, clams, and fish (2). • A portion of the site encompasses the Long Pond Wildlife Refuge (2). • Private landowners own small portions of the property for residential use (2). **Future Land Use:** • The land use is not expected to change in the future (2). **Resource Identification:** • There are approximately 12 public water supply wells within four miles of the Tisbury Great Pond (2). • Estuarine marine wetlands including marine intertidal regularly flooded wetlands, irregularly flooded wetlands, and emergent wetlands are present at the site (2). • The site is located within the Massachusetts Coastal Zone and the Long Point Wildlife Refuge (2). **Potential Receptors:** • Residents, recreation users, on-site workers, and biota(2).	**Property Description:** • The impact area of the site consists of inland water, adjacent marshes, a small strip of beach, and the Atlantic Ocean. • Present land use includes recreational use with moderate to high disturbance due to the breaching of the barrier sand dune. **Potential Ecological Receptors:** • Inland and marine plant species, fish, birds, insects, soil invertebrates, and mammals that inhabit or migrate through the site. Associated threatened and endangered species are included. **Threatened and Endangered Species:** • There are approximately 37 federal and state threatened, endangered, or special concern species that could be present at the site. (1) **Relationship of MEC/MD to Habitat:** • MEC/MD items may be located within and/or adjacent to habitat areas.

Notes:

(1) UXB International, Inc., 2011. *Final Revision 1, Remedial Investigation Work Plan, Former Cape Poge Little Neck Bomb Target MRS, Former Moving Target Machine Gun Range at South Beach MRS, & Tisbury Great Pond MRS, Martha’s Vineyard, Massachusetts*. January.

(2) Alion Science and Technology, 2008. *Final Site Inspection Report for Tisbury Great Pond*. September.

APPENDIX B: INSTITUTIONAL ANALYSIS

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JANUARY 2015

INSTITUTIONAL ANALYSIS REPORT

TISBURY GREAT POND
MUNITIONS RESPONSE AREA
MARTHA'S VINEYARD, MASSACHUSETTS

FUDS Property No. D01MA0453
Contract No. W912DY-04-D-0019
Task Order No. 0006

U. S. ARMY CORPS OF ENGINEERS
NEW ENGLAND DISTRICT

Prepared by:
UXB International, Inc.

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ACRONYMS

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
MADEP	Massachusetts Department of Environmental Protection
MEC	munitions and explosives of concern
MMRP	Military Munitions Response Program
MRA	munitions response area
MRS	munitions response site
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
TPP	Technical Project Planning
TTOR	The Trustees of Reservations
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Command
U.S.	United States
USC	United States Code

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1.0 PURPOSE OF THE STUDY

This 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 Tisbury Great Pond Munitions Response Site (MRS), located within the Tisbury Great Pond Munitions Response Area (MRA). The MRS and MRA are Formerly Used Defense Site (FUDS) Property Number D01MA0453, located on Martha's Vineyard, Massachusetts. The purpose of this report is to document the information collected from Institutional Analysis Questionnaires which were distributed to determine the stakeholders having jurisdiction over the MRS and to access the capability and willingness of these entities to assert LUCs that would protect the public from any hazards potentially present associated with munitions and explosives of concern (MEC) within the limits of the MRS.

The Feasibility Study (FS) was performed in support of the Department of Defense (DoD) Military Munitions Response Program (MMRP). UXB International, Inc. was authorized to conduct the FS through a United States Army Engineering Support Center, Huntsville Contract, No. W912DY-04-D-0019, Task Order No. 006.

2.0 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 the 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, such as fences or signs. The legal mechanisms are generally the same as those used for institutional controls (ICs) as discussed in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). 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, which can also be ICs, 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. 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 MRSs referred to the United States Army Corps of Engineers (USACE) guidance Engineering Pamphlet (EP) 1110-1-24 for Establishing and Maintaining Institutional Controls for Ordnance and Explosive Projects (USACE, 2000). The main objective is to design controls that rely on legal mechanisms, physical barriers or warnings, or administrative mechanisms such as construction support or educational components to restrict access 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 and 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 and 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 MRS and included a review of the government 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, and through the development of questionnaires sent to all stakeholders. Once jurisdiction and ownership were determined, information concerning these entities was reviewed, including:

- 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 Tisbury Great Pond MRS to support the FS effort.

3.0 SCOPE OF EFFORT

The Institutional Analysis was prepared in accordance with United States (U.S.) 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 Projects* (USACE, 2000). The scope of effort for the Institutional Analysis is to collect information and document which stakeholder entities have jurisdiction over the Tisbury Great Pond 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 public safety awareness actions for the property; and, defines and analyzes intergovernmental relationships, joint responsibilities, LUC functions, technical capabilities, funding sources, and recommendations.

4.0 SELECTION CRITERIA

Based on relevance to the IC process for the MRS, the following agencies and organizations were selected for the Institutional Analysis including:

1. Department of the Army;
2. Massachusetts Department of Environmental Protection (MADEP);
3. The Trustees of Reservations (TTOR);
4. Town of Chilmark, Massachusetts;
5. Town of West Tisbury, Massachusetts;
6. Town of Chilmark, Shellfish Advisory Committee;
7. Quansoo Beach Association;
8. Riparian Owners of Tisbury Great Pond; and,
9. Sheriff’s Meadow Foundation.

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.

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 Defense Environmental Restoration Program (DERP) statute [10 United States Code (USC) § 2701 et seq.], Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (42 USC § 9601 et seq.), Executive Orders 12580 and 13016, the NCP, and all applicable DoD [e.g., EP 1110-1-18 (USACE, 2006), Engineering Regulation (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 not owned by the DoD, USACE has minimal control relative to implementing, maintaining, monitoring, or enforcing ICs.

Massachusetts Department of Environmental Protection: MADEP is the support agency providing regulatory support for remedial decision-making at the MRS. MADEP 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. MADEP 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, MADEP 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 or capable to contribute to funding for LUCs.

The Trustees of Reservations: TTOR is a non-profit land conservation and historic preservation organization dedicated to preserving natural and historical places in the Commonwealth of Massachusetts. TTOR owns and manages the Long Point Wildlife Refuge, which encompasses the majority of the land on the eastern portion of the Tisbury Great Pond MRS. TTOR does not have local zoning or enforcement authority. Based on the response received from solicitations regarding willingness and capability to participate in LUCs at the MRS, TTOR indicated that the organization would be willing to produce copies of informational fact sheets/notices, allow for the installation of warning signs, distribute information provided by USACE to site workers, and supports LUCs as part of a remedial alternative, but was not willing or capable to contribute to funding for LUCs.

Town of Chilmark: The Town of Chilmark officials, responders, and various natural resource agencies have interest and involvement in the FUDS project, which were coordinated with throughout the project. Specifically, Chilmark 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 presentations at TPP meetings and local responders have been alerted to munitions discovered at the MRS through the 911 system. The Town of Chilmark does not have local zoning or enforcement authority since the MRS is outside of town limits. Although the MRS boundary is outside of town limits, the Town of Chilmark is willing to distribute information provided by USACE, contribute to the cost of providing fact sheets to site workers, and supports LUCs as part of a remedial alternative. A questionnaire was also sent to the Chilmark Shellfish Advisory Committee, from which a response was not received.

Town of West Tisbury: The town of West Tisbury officials, responders, and various agencies have interest and involvement in the FUDS project, which were coordinated with throughout the project. Specifically, West Tisbury 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 presentations at TPP meetings and local responders have been alerted to munitions discovered at the MRS through the 911 system. Based upon the response received, the Town of West Tisbury would be willing to produce copies of informational fact sheets/notices, allow for the installation of warning signs, distribute information provided by USACE to site workers, enforce zoning laws and land use permits, and supports LUCs as part of a remedial alternative. The Town of West Tisbury was not willing or capable to contribute to funding for LUCs. Responses to the questionnaire were received from multiple departments of the Town of West Tisbury including the Board of Health, Inspector, Conservation Commission, and the Planning Board. Each of the departments, with the exception of the Planning Board, indicated that the departments would be willing to distribute information provided by USACE regarding the LUCs.

Quansoo Beach Association: No response was received.

Riparian Owners Association: No response was received.

Sheriff’s Meadow Foundation: The Sheriff’s Meadow Foundation is an organization that seeks to conserve the natural, rural landscape of Martha’s Vineyard. Currently, Sheriff’s Meadow Foundation owns over 2,000 acres of conservation land, including Quansoo Farm located west of Tisbury Great Pond, and holds conservation restrictions on over 850 acres. The foundation does not have local zoning or enforcement authority. Based on the response received from solicitations regarding willingness and capability to participate in LUCs at the MRS, the Sheriff’s Meadow Foundation indicated that the organization would be willing to produce copies of informational fact sheets/notices, allow for the installation of warning signs, distribute information provided by USACE to site workers, but was not willing or capable to contribute to funding for LUCs.

5.0 ACCEPTANCE OF JOINT RESPONSIBILITY

The agencies and organizations listed in Section 4 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 investigation 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, the landowners (TTOR and the Town of West Tisbury) both responded to the questionnaire developed by USACE to facilitate the Institutional Analysis. Therefore, the willingness and capabilities of public landowners are known.

6.0 TECHNICAL CAPABILITY

Several private residences are located within the MRS. However, the technical capabilities of these residences to provide support for LUCs are unknown. Minimal technical capabilities are needed for TTOR, Sheriff's Meadow Foundation, the town of Chilmark, and the Town of West Tisbury, including officials and natural resource agencies, to provide specific awareness to the property users. 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.

7.0 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. MADEP is the support regulatory agency for remedial decision-making at the MRS. Both agencies have worked successfully to perform investigation and response efforts to date. The landowners (TTOR and the Town of West Tisbury) have control and jurisdiction over the land within the MRS in accordance with land use, ordinance, and zoning rules for the Town of West Tisbury.

8.0 STABILITY

The Town of West Tisbury, the Town of Chilmark, USACE, and MADEP are all considered stable institutions.

9.0 FUNDING SOURCES

Funding has been provided through the Army FUDS program. Additional funding will be required through the ER-FUDS account to implement a remedial alternative for the MRS. None of the organizations that responded to the questionnaire indicated that they would be willing or capable to fund IC components for the MRS as part of a remedial alternative.

10.0 RECOMMENDATIONS

There are no existing LUCs currently at the MRS. All project stakeholders will continue to be involved in the selection of a final remedy and implementation for the MRS in accordance with CERCLA and the NCP. In the FS, the following remedial action objective was established for the Tisbury Great Pond MRS: to protect recreational users, landowners, visitors, and workers at the MRS from explosive hazards associated with MEC exposure in the dunes and in the top 3 feet of subsurface soil or sediment during intrusive activities and by dune erosion. Informational materials and educational LUC components to provide awareness and affect human behavior have been identified that are either considered a remedial alternative themselves, or will support an active clearance option being contemplated in the FS.

Based on the results of the Institutional Analysis, USACE shall manage and execute establishment of all LUC components, if any, included in the final remedy selected. Funding will be required through the ER-FUDS account to implement LUCs for the MRS. MADEP, TTOR, the Town of Chilmark, the Town of West Tisbury, and Sheriff's Meadow Foundation are willing to provide support to distribute information provided by USACE; however, none are willing or capable to contribute to funding for LUCs.

11.0 REFERENCES

Code of Federal Regulations, Title 40 -*Protection of Environment,* Volume 28, Chapter I, Part 300-*National Oil And Hazardous Substances Pollution Contingency Plan.*

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USAEC (U.S. Army Environmental Command), 2009. *Final Military Munitions Response Program, Munitions Response Remedial Investigation/Feasibility Study Guidance.* October 2009.

United States Environmental Protection Agency (EPA), 1988. Interim Final *Guidance for Conducting Remedial Investigation and Feasibility Studies Under CERCLA.* October.

APPENDIX C: MEC HAZARD ASSESSMENT

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MEC HA Summary Information

		Comments
Site ID:	FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of Investigation)	
Date:	7/30/2013	

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

A. Enter a unique identifier for the site:

	Comments
Former Tisbury Great Pond Bomb Target, Land/Beach Areas	MEC HA does not include underwater areas (inland water and ocean)

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

Ref. No.	Title (include version, publication date)
1	United States Army Corps of Engineers (USACE), 1999. *Final, Archives Search Report for the former Tisbury Great Pond, Martha's Vineyard Massachusetts*. November.
2	USACE, 2008. Final, Site Inspection Report For Tisbury Great Pond. September.
3	*Explosives Site Plan, Correction 1, Remedial Investigation/Feasibility Study, Former Cape Poge Little Neck Bomb Target Site, Former Moving Target Machine Gun Range, Tisbury Great Pond, Martha's Vineyard, Massachusetts, D01MA0595*. USAECH, 2010.
4	*Final Revision 3, Remedial Investigation Work Plan: Former Cape Poge Little Neck Bomb Target MRS, Former Moving Target Machine Gun Range at South Beach MRS, Tisbury Great Pond MRS, Martha's Vineyard, Massachusetts*. UXB, 2011.
5	AAR, Emergency Response (Between 19 August 2009 and 13 July 2011, VHR responded to three emergency calls and US Navy EOD responded to a fourth associated with potential ordnance)

B. Briefly describe the site:

1. Area (include units): Total area is 768.3 acres of which 259.6 is land/beach, and the balance is inland water/ocean surfzone

The FUDS boundary was expanded based upon previously identified MEC and/or MD.

2. Past munitions-related use:

Target Area

3. Current land-use activities (list all that occur):

Hiking, biking, recreational activities, residential, and TTOR maintenance

4. Are changes to the future land-use planned? No

5. What is the basis for the site boundaries?

The expanded Area of Investigation boundary was based upon previously identified MEC and/or MD.

6. How certain are the site boundaries?

Site boundaries can be reduced based on RI field work, but the vicinity of target areas has documented contamination.

Reference(s) for Part B:

United States Army Corps of Engineers (USACE), 1999. Final, Archives Search Report for the former Tisbury Great Pond, Martha's Vineyard Massachusetts. November.

[redacted]

C. Historical Clearances

1. Have there been any historical clearances at the site? Yes, subsurface clearance

2. If a clearance occurred:

a. What year was the clearance performed? 2009-2011

b. Provide a description of the clearance activity (e.g., extent, depth, amount of munitions-related items removed, types and sizes of removed items, and whether metal detectors were used):

UXO Emergency Response by VRHabilis and US Navy EOD between August 2009 and July 2011. Items recovered included a suspect HE bomb (BIP) and miscellaneous items of MD removed/recyled.

Reference(s) for Part C:

AAR, UXO Emergency Resopnse, VRHabilis, 2009-2011

[redacted]

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

Site ID: **FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of Investigation)**
Date: **7/30/2013**

Activities Currently Occurring at the Site

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours per year a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1	Hiking, Biking, Recreational Activities	25,000	6	**150,000**	1	25,000 registered guests per year (TToR Records), 6 hours per trip
2	Residential	150	5,840	**876,000**	4	16 hours per day, year round
3	TTOR Maintenance	4	390	**1,560**	2	
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr): **1,027,560**
Maximum intrusive depth at site (ft): **4**

Reference(s) for table above:

ASR

[redacted]

Site ID: **FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of Investigation)**
Date: **7/30/2013**

Cased Munitions Information

Item No.	Munition Type (e.g., mortar, projectile, etc.)	Munition Size	Munition Size Units	Mark/ Model	Energetic Material Type	Is Munition Fuzed?	Fuzing Type	Fuze Condition	Minimum Depth for Munition (ft)	Location of Munitions	Comments (include rationale for munitions that are "subsurface only")
1	Bombs	3	lb	AN-MK23	Spotting Charge	No			0	Subsurface Only	From RI investigation
2	Bombs	100	lb	Unknown	High Explosive	Yes	UNK	UNK	0	Subsurface Only	From UXO Emergency Response

Reference(s) for table above:

AAR, UXO Emergency Response, VRHabilis, US Navy EOD, 2009-2011;
Final Revision 3, Remedial Investigation Work Plan: Former Cape Poge Little Neck Bomb Target MRS, Former Moving Target Machine Gun Range at South Beach MRS, Tisbury Great Pond MRS, Martha's Vineyard, Massachusetts. UXB, 2011.

[redacted]

Bulk Explosive Information

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

Reference(s) for table above:

Site ID: **FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of Investigation)**
Date: **7/30/2013**

Planned Remedial or Removal Actions

Response Action No.	Response Action Description	Expected Resulting Minimum MEC Depth (ft)	Expected Resulting Site Accessibility	Will land use activities change if this response action is implemented?	What is the expected scope of cleanup?	Comments
1	Alternative 1: No Action	0	Full Accessibility	No	No MEC cleanup	
2	Alternative 2: Land Use Controls	0	Full Accessibility	No	No MEC cleanup	
3	Alternative 3: Partial Subsurface Clearance with LUCs	3	Full Accessibility	No	cleanup of MECs located both on the surface and subsurface	
4	Alternative 4: Subsurface Clearance	3	Full Accessibility	No	cleanup of MECs located both on the surface and subsurface	
5						
6						

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

Reference(s) for table above:

Site ID: **FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of Investigation)**
Date: **7/30/2013**

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

Land Use Activities Planned After Response Alternative #1: Alternative 1: No Action

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

Land Use Activities Planned After Response Alternative #2: Alternative 2: Land Use Controls

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

Land Use Activities Planned After Response Alternative #3: Alternative 3: Partial Subsurface Clearance with LUCs

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

[redacted]

Land Use Activities Planned After Response Alternative #4: Alternative 4: Subsurface Clearance

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

[redacted]

Land Use Activities Planned After Response Alternative #5:

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

[redacted]

Land Use Activities Planned After Response Alternative #6:

Activity No.	Activity	Number of people per year who participate in the activity	Number of hours a single person spends on the activity	Potential Contact Time (receptor hours/year)	Maximum intrusive depth (ft)	Comments
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						

Total Potential Contact Time (receptor hrs/yr):

Maximum intrusive depth at site (ft):

Reference(s) for table above:

[redacted]

Site ID: **FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of Investigation)**
Date: **7/30/2013**

Energetic Material Type Input Factor Categories

Comments

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

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

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

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

Location of Additional Human Receptors Input Factor Categories

1. What is the Explosive Safety Quantity Distance (ESQD) from the Explosive Siting Plan or the Explosive Safety Submission for the MRS?	6	feet	non-fragmenting round - K40 uesed
2. Are there currently any features or facilities where people may congregate within the MRS, or within the ESQD arc?	Yes		

3. Please describe the facility or feature.

Residential, TTOR land, Cape Poge Lighthouse

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

Item #1. Bombs (3lb, Spotting Charge)
Item #2. Bombs (3lb, Spotting Charge)

[redacted]

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

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

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

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

6. Please describe the facility or feature.

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

[redacted]

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

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

7. Please answer Question 5 above to determine the scores.	***Score***
Baseline Conditions:	
Surface Cleanup:	
Subsurface Cleanup:	

Site Accessibility Input Factor Categories

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

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

Current Use Activities

Score

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

Full Accessibility

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

Future Use Activities

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

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Reference(s) for above information:

Response Alternative No. 1: Alternative 1: No Action

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

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

Response Alternative No. 2: Alternative 2: Land Use Controls

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

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

Response Alternative No. 3: Alternative 3: Partial Subsurface Clearance with LUCs

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

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

Response Alternative No. 4: Alternative 4: Subsurface Clearance

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

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

Response Alternative No. 5:

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

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 6:

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

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Potential Contact Hours Input Factor Categories

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

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

Current Use Activities :

Input factors are only determined for baseline conditions for current use activities. Based on the 'Current and Future Activities' Worksheet, the Total Potential Contact Time is: **1,027,560** receptor hrs/yr

Based on the table above, this corresponds to a input factor score for baseline conditions of: **120** Score

Future Use Activities :

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

Based on the table above, this corresponds to a input factor score of: Score

Response Alternative No. 1: Alternative 1: No Action

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

Total Potential Contact Time, based on the contact time listed for current use activities (see 'Current and Future Activities' Worksheet)	**1,027,560**
Based on the table above, this corresponds to input factor scores of:	***Score***
Baseline Conditions:	**120**
Surface Cleanup:	**90**
Subsurface Cleanup:	**30**

Response Alternative No. 2: Alternative 2: Land Use Controls

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

Total Potential Contact Time, based on the contact time listed for current use activities (see 'Current and Future Activities' Worksheet)	**1,027,560**
Based on the table above, this corresponds to input factor scores of:	***Score***
Baseline Conditions:	**120**
Surface Cleanup:	**90**
Subsurface Cleanup:	**30**

Response Alternative No. 3: Alternative 3: Partial Subsurface Clearance with LUCs

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

Total Potential Contact Time, based on the contact time listed for current use activities (see 'Current and Future Activities' Worksheet)	**1,027,560**
Based on the table above, this corresponds to input factor scores of:	***Score***
Baseline Conditions:	**120**
Surface Cleanup:	**90**
Subsurface Cleanup:	**30**

Response Alternative No. 4: Alternative 4: Subsurface Clearance

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

Total Potential Contact Time, based on the contact time listed for current use activities (see 'Current and Future Activities' Worksheet)	**1,027,560**
Based on the table above, this corresponds to input factor scores of:	***Score***
Baseline Conditions:	**120**
Surface Cleanup:	**90**
Subsurface Cleanup:	**30**

Response Alternative No. 5:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time

Based on the table above, this corresponds to input factor scores of: **Score**
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 6:

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Total Potential Contact Time

Based on the table above, this corresponds to input factor scores of: **Score**
Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Amount of MEC Input Factor Categories

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

	Description	Baseline Conditions	Surface Cleanup	Subsurface Cleanup
Target Area	Areas at which munitions fire was directed	180	120	30
OB/OD Area	Sites where munitions were disposed of by open burn or open detonation methods. This category refers to the core activity area of an OB/OD area. See the "Safety Buffer Areas" category for safety fans and kick-outs.	180	110	30

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

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

Target Area

	Score
Baseline Conditions:	**180**
Surface Cleanup:	**120**
Subsurface Cleanup:	**30**

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

Current Use Activities

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

The deepest intrusive depth: **4** ft

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

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

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

240 ***Score***

Future Use Activities

Deepest intrusive depth: ft

Not enough information has been entered to determine the input factor category.

Score

Response Alternative No. 1: Alternative 1: No Action

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): **0** ft

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

Maximum Intrusive Depth, based on the maximum intrusive depth listed for current use activities (see 'Current and Future Activities' Worksheet) **4** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'

	Score
Baseline Conditions:	**240**
Surface Cleanup:	
Subsurface Cleanup:	

Response Alternative No. 2: Alternative 2: Land Use Controls

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): **0** ft

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

Maximum Intrusive Depth, based on the maximum intrusive depth listed for current use activities (see 'Current and Future Activities' Worksheet) **4** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'

	Score
Baseline Conditions:	**240**
Surface Cleanup:	
Subsurface Cleanup:	

Response Alternative No. 3: Alternative 3: Partial Subsurface Clearance with LUCs

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): **3** ft

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

Maximum Intrusive Depth, based on the maximum intrusive depth listed for current use activities (see 'Current and Future Activities' Worksheet) **4** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup: **95**

Response Alternative No. 4: Alternative 4: Subsurface Clearance

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): **3** ft

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

Maximum Intrusive Depth, based on the maximum intrusive depth listed for current use activities (see 'Current and Future Activities' Worksheet) **4** ft

Because the shallowest minimum MEC depth is less than or equal to the deepest intrusive depth, the intrusive depth overlaps. MECs are located at both the surface and subsurface, based on the 'Munitions, Bulk Explosive Info' Worksheet. Therefore, the category for this input factor is 'Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.'

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup: **95**

Response Alternative No. 5:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

Score

Baseline Conditions:
Surface Cleanup:
Subsurface Cleanup:

Response Alternative No. 6:

Expected minimum MEC depth (from the 'Planned Remedial or Removal Actions' Worksheet): ft

Not enough information has been entered in the 'Planned Remedial or Removal Actions' Worksheet. Please complete the table before returning to this section.

Maximum Intrusive Depth ft

Not enough information has been entered to calculate this input factor.

	Score
Baseline Conditions:	
Surface Cleanup:	
Subsurface Cleanup:	

Migration Potential Input Factor Categories

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

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

Erosion is most critical

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

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

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

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

Reference(s) for above information:

Draft Preliminary Assessment, Cape Poge Little Neck Bomb Target Site, Chappaquiddick Island, MA, FUDS Property Number - D01MA0595. USACE, 2009.

Final Revision 3, Remedial Investigation Work Plan: Former Cape Poge Little Neck Bomb Target MRS, Former Moving Target Machine Gun Range at South Beach MRS, Tisbury Great Pond MRS, Martha's Vineyard, Massachusetts. UXB, 2011.

[redacted]

MEC Classification Input Factor Categories

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

The 'Amount of MEC' category is 'Target Area'. It cannot be automatically assumed that the MEC items from this category are DMM. Therefore, the conservative assumption is that the MEC items in this MRS are UXO.

Has a technical assessment shown that MEC in the OB/OD Area is DMM?	
Are any of the munitions listed in the 'Munitions, Bulk Explosive Info' Worksheet:	No

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

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

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

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

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

	Score
Baseline Conditions:	**110**
Surface Cleanup:	**110**
Subsurface Cleanup:	**110**

MEC Size Input Factor Categories

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

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

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

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

Scoring Summary

Site ID: **FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of Investigation)**	**a. Scoring Summary for Current Use Activities**	
Date: **7/30/2013**	**Response Action Cleanup:**	**Response**
Input Factor	**Input Factor Category**	**Score**
I. Energetic Material Type	High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors	Inside the MRS or inside the ESQD arc	30
III. Site Accessibility	Full Accessibility	80
IV. Potential Contact Hours	≥1,000,000 receptor-hrs/yr	120
V. Amount of MEC	Target Area	180
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth	Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential	Possible	30
VIII. MEC Classification	UXO	110
IX. MEC Size	Small	40
	Total Score	**930**
	Hazard Level Category	**1**

Site ID: **FUDS No. D01MA0453 (Former Ti**	**b. Scoring Summary for Future Use Activities**	
Date: **7/30/2013**	**Response Action Cleanup:**	**Response**
Input Factor	**Input Factor Category**	**Score**
I. Energetic Material Type		
II. Location of Additional Human Receptors		
III. Site Accessibility		
IV. Potential Contact Hours		
V. Amount of MEC		
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		
VII. Migration Potential		
VIII. MEC Classification		
IX. MEC Size		
	Total Score	
	Hazard Level Category	

Site ID: **FUDS No. D01MA0453 (Former Ti**	**c. Scoring Summary for Response Alternative 1: Alternative 1: No Action**	
Date: **7/30/2013**	**Response Action Cleanup:**	**No MEC cleanup**
Input Factor	**Input Factor Category**	**Score**
I. Energetic Material Type	High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors	Inside the MRS or inside the ESQD arc	30
III. Site Accessibility	Full Accessibility	80
IV. Potential Contact Hours	≥1,000,000 receptor-hrs/yr	120
V. Amount of MEC	Target Area	180
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth	Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential	Possible	30
VIII. MEC Classification	UXO	110
IX. MEC Size	Small	40
	Total Score	**930**
	Hazard Level Category	**1**

Site ID:	**FUDS No. D01MA0453 (Former Ti**	**d. Scoring Summary for Response Alternative 2: Alternative 2: Land Use Control**	
Date:	**7/30/2013**	**Response Action Cleanup:**	**No MEC cleanup**
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		≥1,000,000 receptor-hrs/yr	120
V. Amount of MEC		Target Area	180
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	240
VII. Migration Potential		Possible	30
VIII. MEC Classification		UXO	110
IX. MEC Size		Small	40
		Total Score	**930**
		Hazard Level Category	**1**

Site ID:	**FUDS No. D01MA0453 (Former Ti**	**e. Scoring Summary for Response Alternative 3: Alternative 3: Partial Subsurfac**	
Date:	**7/30/2013**	**Response Action Cleanup:**	**of MECs located**
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		≥1,000,000 receptor-hrs/yr	30
V. Amount of MEC		Target Area	30
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	95
VII. Migration Potential		Possible	10
VIII. MEC Classification		UXO	110
IX. MEC Size		Small	40
		Total Score	**525**
		Hazard Level Category	**4**

Site ID:	**FUDS No. D01MA0453 (Former Ti**	**f. Scoring Summary for Response Alternative 4: Alternative 4: Subsurface Cleara**	
Date:	**7/30/2013**	**Response Action Cleanup:**	**of MECs located**
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	100
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	30
III. Site Accessibility		Full Accessibility	80
IV. Potential Contact Hours		≥1,000,000 receptor-hrs/yr	30
V. Amount of MEC		Target Area	30
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth		Baseline Condition: MEC located surface and subsurface. After Cleanup: Intrusive depth overlaps with subsurface MEC.	95
VII. Migration Potential		Possible	10
VIII. MEC Classification		UXO	110
IX. MEC Size		Small	40
		Total Score	**525**
		Hazard Level Category	**4**

Site ID:	**FUDS No. D01MA0453 (Former Ti**	**g. Scoring Summary for Response Alternative 5:**	
Date:	**7/30/2013**	**Response Action Cleanup:**	
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	
III. Site Accessibility			
IV. Potential Contact Hours			
V. Amount of MEC		Target Area	
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth			
VII. Migration Potential		Possible	
VIII. MEC Classification		UXO	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

Site ID:	**FUDS No. D01MA0453 (Former Ti**	**g. Scoring Summary for Response Alternative 6:**	
Date:	**7/30/2013**	**Response Action Cleanup:**	
Input Factor		**Input Factor Category**	**Score**
I. Energetic Material Type		High Explosive and Low Explosive Filler in Fragmenting Rounds	
II. Location of Additional Human Receptors		Inside the MRS or inside the ESQD arc	
III. Site Accessibility			
IV. Potential Contact Hours			
V. Amount of MEC		Target Area	
VI. Minimum MEC Depth Relative to Maximum Intrusive Depth			
VII. Migration Potential		Possible	
VIII. MEC Classification		UXO	
IX. MEC Size		Small	
		Total Score	
		Hazard Level Category	

MEC HA Hazard Level Determination			
Site ID:	**FUDS No. D01MA0453 (Former Tisbury Great Pond Bomb Target Area of**		
Date:	**7/30/2013**		
		Hazard Level Category	**Score**
a. Current Use Activities		**1**	**930**
b. Future Use Activities			
c. Response Alternative 1: Alternative 1: No Action		**1**	**930**
d. Response Alternative 2: Alternative 2: Land Use Controls		**1**	**930**
Clearance with LUCs		**4**	**525**
f. Response Alternative 4: Alternative 4: Subsurface Clearance		**4**	**525**
g. Response Alternative 5:			
h. Response Alternative 6:			

Characteristics of the MRS	
Is critical infrastructure located within the MRS or within the ESQD arc?	Yes
Are cultural resources located within the MRS or within the ESQD arc?	Yes
Are significant ecological resources located within the MRS or within the ESQD arc?	Yes

APPENDIX D: COST ESTIMATES

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Great Pond MRS
Alternative 1
No Further Action

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Cost Per Acre	Total
0100	Work and Safety Plans, UFP-QAPP, TPP	0.00	LS	N/A	N/A	N/A	$ 97,169	N/A	$ -
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	$ 23,515	N/A	$ -
0200	Mobilization - Per Person	0.00	Person	N/A	N/A	N/A	$ 1,756	N/A	$ -
0300	Site Management	0.00	Week	1.00	1	0.00	$ 49,906	N/A	$ -
0310	Survey/Positioning	0.00	AC	10.00	1	0.00	$ 15,389	$ -	$ -
0320	Brush Clearing	0.00	AC	12.00	1	0.00	$ 2,865	$ -	$ -
0330	Environmental Monitoring and Coordination (Habitat Survey)	0.00	AC	15.00	1	0.00	$ 39,621	$ -	$ -
0400	MEC Surface Removal	0.00	AC	3.00	2	0.00	$ 43,586	$ -	$ -
0410	MEC Sub-surface Removal, Analogue	0.00	AC	2.00	1	0.00	$ 45,168	$ -	$ -
0420	Digital Geophysical Mapping	0.00	AC	3.00	1	0.00	$ 21,389	$ -	$ -
0430	Digital Data Analysis	0.00	AC	3.00	1	0.00	$ 9,164	$ -	$ -
0440	Anomaly Reacquisition	0.00	AC	2.00	2	0.00	$ 15,389	$ -	$ -
0450	Anomaly Resolution	0.00	AC	2.00	2	0.00	$ 45,168	$ -	$ -
0460	Dune MEC Removal - Sand Sifting	0.00	CY	400.00	3	0.00	$ 46,205	$ -	$ -
0500	Underwater MEC Removal - No Divers	0.00	AC	1.00	2	0.00	$ 45,685	$ -	$ -
0510	Underwater MEC Removal - Divers	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0520	DGM - Underwater	0.00	AC	4.0	1	0.00	$ 25,099	$ -	$ -
0540	Anomaly Resolution - Underwater	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0600	MDAS Certification and Disposal	0.00	LS	0.2	1	0.00	$ 19,545	N/A	$ -
0610	Site Restoration	0.00	LS	0.1	1	0.00	$ 36,159	N/A	$ -
0620	Demobilization	0.00	Person	N/A	N/A	N/A	$ 690	N/A	$ -
0700	Remedial Action Completion Report	0.00	LS	N/A	N/A	N/A	$ 78,598	N/A	$ -
0710	Land Use Control Plan	0.00	LS	N/A	N/A	N/A	$ 36,741	N/A	$ -
0800	Land Use Control Implementation	0.00	LS	N/A	N/A	N/A	$ 94,328	N/A	$ -
0810	Annual Post-Construction Revegetation Monitoring	0.00	Year	N/A	N/A	N/A	$ 27,695	N/A	$ -
	Sub-Total								$ -
	Contingency	15%							$ -
	Sub-Total								$ -
	Infrastructure Improvements	2%							$ -
	Project Management	5%							$ -
	Remedial Design (USACE)	8%							$ -
	Construction Management (USACE)	6%							$ -
	Total Capital Cost								**$ -**

LONG-TERM MANAGEMENT COST:

	Description	Year	QTY	Unit	Unit Cost	Total
900	Long-Term Management	1-30	0	EA	$ 5,408	$ -
910	UXO On-call Support	1-30	0	EA	$ 10,422	$ -
	Sub-Total					$ -
	Contingency 15%					$ -
	Project Management 5%					$ -
	Total Long-Term Management Cost					**$ -**

ALTERNATIVE 2: TOTAL CAPITAL AND LONG-TERM MANAGEMENT COST: **$ -**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0820	Five Year Review (cost per review) **5 Year Review not included in total alternative cost estimate*	5	1	EA	$ 42,166	$ 42,166

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

Great Pond MRS
Alternative 2
Land Use Controls

CAPITAL COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Cost Per Acre	Total
0100	Work and Safety Plans, UFP-QAPP, TPP	0.00	LS	N/A	N/A	N/A	$ 97,169	N/A	$ -
0110	Explosive Safety Submission	0.00	LS	N/A	N/A	N/A	$ 23,515	N/A	$ -
0200	Mobilization - Per Person	0.00	Person	N/A	N/A	N/A	$ 1,756	N/A	$ -
0300	Site Management	0.00	Week	1.00	1	0.00	$ 49,906	N/A	$ -
0310	Survey/Positioning	0.00	AC	10.00	1	0.00	$ 15,389	$ -	$ -
0320	Brush Clearing	0.00	AC	12.00	1	0.00	$ 2,865	$ -	$ -
0330	Environmental Monitoring and Coordination (Habitat Survey)	0.00	AC	15.00	1	0.00	$ 39,621	$ -	$ -
0400	MEC Surface Removal	0.00	AC	3.00	2	0.00	$ 43,586	$ -	$ -
0410	MEC Sub-surface Removal, Analogue	0.00	AC	2.00	1	0.00	$ 45,168	$ -	$ -
0420	Digital Geophysical Mapping	0.00	AC	3.00	1	0.00	$ 21,389	$ -	$ -
0430	Digital Data Analysis	0.00	AC	3.00	1	0.00	$ 9,164	$ -	$ -
0440	Anomaly Reacquisition	0.00	AC	2.00	2	0.00	$ 15,389	$ -	$ -
0450	Anomaly Resolution	0.00	AC	2.00	2	0.00	$ 45,168	$ -	$ -
0460	Dune MEC Removal - Sand Sifting	0.00	CY	400.00	3	0.00	$ 46,205	$ -	$ -
0500	Underwater MEC Removal - No Divers	0.00	AC	1.00	2	0.00	$ 45,685	$ -	$ -
0510	Underwater MEC Removal - Divers	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0520	DGM - Underwater	0.00	AC	4.0	1	0.00	$ 25,099	$ -	$ -
0540	Anomaly Resolution - Underwater	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0600	MDAS Certification and Disposal	0.00	LS	0.2	1	0.00	$ 19,545	N/A	$ -
0610	Site Restoration	0.00	LS	0.1	1	0.00	$ 36,159	N/A	$ -
0620	Demobilization	0.00	Person	N/A	N/A	N/A	$ 690	N/A	$ -
0700	Remedial Action Completion Report	0.00	LS	N/A	N/A	N/A	$ 78,598	N/A	$ -
0710	Land Use Control Plan	1.00	LS	N/A	N/A	N/A	$ 36,741	N/A	$ 36,741
0800	Land Use Control Implementation	1.00	LS	N/A	N/A	N/A	$ 94,328	N/A	$ 94,328
0810	Annual Post-Construction Revegetation Monitoring	0.00	Year	N/A	N/A	N/A	$ 27,695	N/A	$ -
	Sub-Total								$ 131,069
	Contingency	15%							$ 19,660
	Sub-Total								$ 150,729
	Infrastructure Improvements	2%							$ 3,015
	Project Management	5%							$ 7,536
	Remedial Design (USACE)	8%							$ 12,058
	Construction Management (USACE)	6%							$ 9,044
	Total Capital Cost								**$ 182,383**

LONG-TERM MANAGEMENT COST:

	Description		Year	QTY	Unit	Unit Cost	Total
900	Long-Term Management		1-30	30	EA	$ 5,408	$ 162,239
910	UXO On-call Support		1-30	0	EA	$ 10,422	$ -
	Sub-Total						$ 162,239
	Contingency	15%					$ 24,336
	Project Management	5%					$ 8,112
	Total Long-Term Management Cost						**$ 186,574**

ALTERNATIVE 2: TOTAL CAPITAL AND LONG-TERM MANAGEMENT COST: **$ 368,957**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0820	Five Year Review (cost per review) **5 Year Review not included in total alternative cost estimate*	5	6	EA	$ 42,166	$ 252,999

ALTERNATIVE 3: TOTAL ALTERNATIVE COST PLUS REVIEW COST **$ 621,955**

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

Great Pont MRS
Alternative 3
Partial Subsurface Clearance with Land Use Controls
38.5 Acres of Subsurface Clearance

COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Cost Per Acre	Total
0100	Work and Safety Plans, UFP-QAPP, TPP	1.00	LS	N/A	N/A	N/A	$ 97,169	N/A	$ 97,169
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	$ 23,515	N/A	$ 23,515
0200	Mobilization - Per Person	29.00	Person	N/A	N/A	N/A	$ 1,756	N/A	$ 50,932
0300	Site Management	18.00	Week	1.00	1	18.00	$ 49,906	N/A	$ 898,313
0310	Survey/Positioning	33.50	AC	10.00	1	0.67	$ 15,389	$ 308	$ 10,311
0320	Brush Clearing	5.00	AC	5.00	1	0.20	$ 2,865	$ 2,865	$ 573
0330	Environmental Monitoring and Coordination (Habitat Survey)	1.00	LS	N/A	N/A	N/A	$ 39,621	N/A	$ 39,621
0400	MEC Surface Removal	0.00	AC	3.00	1	0.00	$ 43,586	$ -	$ -
0410	MEC Sub-surface Removal, Analog	0.00	AC	2.00	1	0.00	$ 45,168	$ -	$ -
0420	Digital Geophysical Mapping	33.50	AC	4.00	1	1.68	$ 21,389	$ 1,069	$ 35,826
0430	Digital Data Analysis	33.50	AC	4.00	1	1.68	$ 9,164	$ 458	$ 15,349
0440	Anomaly Reacquisition	33.50	AC	3.00	1	2.23	$ 15,389	$ 1,026	$ 34,370
0450	Anomaly Resolution	33.50	AC	2.50	1	2.68	$ 45,168	$ 3,613	$ 121,049
0460	Dune MEC Removal - Sand Sifting	155,250	CY	400.00	4	19.41	$ 46,205	$ 23	$ 3,586,638
0500	Underwater MEC Removal - No Divers	0.00	AC	1.00	2	0.00	$ 45,685	$ -	$ -
0510	Underwater MEC Removal - Divers	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0520	DGM - Underwater	0.00	AC	4.0	1	0.00	$ 25,099	$ -	$ -
0540	Anomaly Resolution - Underwater	0.00	AC	1.5	2	0.00	$ 86,667	$ -	$ -
0600	MDAS Certification and Disposal	1.00	LS	0.2	1	1.00	$ 19,545	N/A	$ 19,545
0610	Site Restoration	1.00	LS	0.1	1	1.00	$ 36,159	$ 1,166	$ 36,159
0620	Demobilization	29.00	Person	N/A	N/A	N/A	$ 690	N/A	$ 20,016
0700	Remedial Action Completion Report	1.00	LS	N/A	N/A	N/A	$ 78,598	N/A	$ 78,598
0710	Land Use Control Plan	1.00	LS	N/A	N/A	N/A	$ 36,741	N/A	$ 36,741
0800	Land Use Control Implementation	1.00	LS	N/A	N/A	N/A	$ 94,328	N/A	$ 94,328
0810	Annual Post-Construction Revegetation Monitoring	3.00	Year	N/A	N/A	N/A	$ 27,695	N/A	$ 83,085
	Sub-Total								$ 5,282,138
	Contingency	15%							$ 792,321
	Sub-Total								$ 6,074,459
	Infrastructure Improvements	2%							$ 121,489
	Project Management	5%							$ 303,723
	Remedial Design (USACE)	8%							$ 485,957
	Construction Management (USACE)	6%							$ 364,468
	Total Cost								**$ 7,350,095**

LONG-TERM MANAGEMENT COST:

	Description		Year	QTY	Unit	Unit Cost	Total
900	Long-Term Management		1-30	30	EA	$ 13,882	$ 416,460
910	UXO On-call Support		1-30	0	EA	$ 6,157	$ -
	Sub-Total						$ 416,460
	Contingency	15%					$ 62,469
	Project Management	5%					$ 20,823
	Total Long-Term Management Cost					$ 5,408	**$ 478,929**
						$ 10,422	

ALTERNATIVE 3: TOTAL CAPITAL AND LONG-TERM MANAGEMENT COST: **$ 7,829,024**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0820	Five Year Review (cost per review)	5	6	EA	$ 41,739	$ 250,434

ALTERNATIVE 3: TOTAL ALTERNATIVE COST PLUS REVIEW COST **$ 8,079,458**

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

Tisbury Great Pond MRS
Alternative 4
Complete Subsurface Clearance
123 Acres (land and water)

COST:

Bid Item No.	Description	QTY	Unit	Team Production (Units/Day)	# Teams	Duration (Weeks)	Weekly Cost Per Team	Cost Per Acre	Total
0100	Work and Safety Plans, UFP-QAPP, TPP	1.00	LS	N/A	N/A	N/A	$ 97,169	N/A	$ 97,169
0110	Explosive Safety Submission	1.00	LS	N/A	N/A	N/A	$ 23,515	N/A	$ 23,515
0200	Mobilization - Per Person	29.00	Person	N/A	N/A	N/A	$ 1,756	N/A	$ 50,932
0300	Site Management	32.00	Week	1.00	1	32.00	$ 49,906	N/A	$ 1,597,000
0310	Survey/Positioning	33.50	AC	10.00	1	0.67	$ 15,389	$ 308	$ 10,311
0320	Brush Clearing	5.00	AC	1.00	1	1.00	$ 2,865	$ 2,865	$ 2,865
0330	Environmental Monitoring and Coordination (Habitat Survey)	1.00	LS	N/A	N/A	N/A	$ 39,621	$ 39,621	$ 39,621
0400	MEC Surface Removal	0.00	AC	3.00	2	0.00	$ 43,586	$ -	$ -
0410	MEC Sub-surface Removal, Analog	0.00	AC	2.00	1	0.00	$ 45,168	$ -	$ -
0420	Digital Geophysical Mapping	33.50	AC	4.00	1	1.68	$ 21,389	$ 1,069	$ 35,826
0430	Digital Data Analysis	33.50	AC	4.00	1	1.68	$ 9,164	$ 458	$ 15,349
0440	Anomaly Reacquisition	33.50	AC	3.00	1	2.23	$ 15,389	$ 1,026	$ 34,370
0450	Anomaly Resolution	33.50	AC	2.50	1	2.68	$ 45,168	$ 3,613	$ 121,049
0460	Dune MEC Removal - Sand Sifting	155,250	CY	400.00	4	19.41	$ 46,205	$ 23	$ 3,586,638
0500	Underwater MEC Removal - No Divers	7.00	AC	1.00	2	0.70	$ 45,685	$ -	$ 63,959
0510	Underwater MEC Removal - Divers	21.00	AC	1.5	2	1.40	$ 86,667	$ -	$ 242,667
0520	DGM - Underwater	56.00	AC	4.0	1	2.80	$ 25,099	$ -	$ 70,278
0540	Anomaly Resolution - Underwater	56.00	AC	1.5	2	3.73	$ 86,667	$ -	$ 647,113
0600	MDAS Certification and Disposal	1.00	LS	0.2	1	1.00	$ 19,545	N/A	$ 19,545
0610	Site Restoration	1.00	LS	0.1	1	2.00	$ 36,159	$ 583	$ 72,319
0620	Demobilization	29.00	Person	N/A	N/A	N/A	$ 690	N/A	$ 20,016
0700	Remedial Action Completion Report	1.00	LS	N/A	N/A	N/A	$ 78,598	N/A	$ 78,598
0710	Land Use Control Plan	1.00	LS	N/A	N/A	N/A	$ 36,741	N/A	$ 36,741
0800	Land Use Control Implementation	1.00	LS	N/A	N/A	N/A	$ 94,328	N/A	$ 94,328
0810	Annual Post-Construction Revegetation Monitoring	3.00	Year	N/A	N/A	N/A	$ 27,695	N/A	$ 83,085
	Sub-Total								$ 7,043,294
	Contingency	15%							$ 1,056,494
	Sub-Total								$ 8,099,788
	Infrastructure Improvements	2%							$ 161,996
	Project Management	5%							$ 404,989
	Remedial Design (USACE)	8%							$ 647,983
	Construction Management (USACE)	6%							$ 485,987
	Total Cost								**$ 9,800,743**

LONG-TERM MANAGEMENT COST:

	Description		Year	QTY	Unit	Unit Cost	Total
900	Long-Term Management		1-4	4	EA	$ 5,408	$ 21,632
910	UXO On-call Support		1-4	0	EA	$ 10,422	$ -
	Sub-Total						$ 21,632
	Contingency	15%					$ 3,245
	Project Management	5%					$ 1,082
	Total Long-Term Management Cost						**$ 24,877**

ALTERNATIVE 4: TOTAL CAPITAL AND LONG-TERM MANAGEMENT COST: **$ 9,825,620**

PERIODIC COST:

	Description	Year	QTY	Unit	Unit Cost	Total
0820	Five Year Review (cost per review)	5	1	EA	$ 42,166	$ 42,166

ALTERNATIVE 4: TOTAL ALTERNATIVE COST PLUS REVIEW COST **$ 9,867,786**

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